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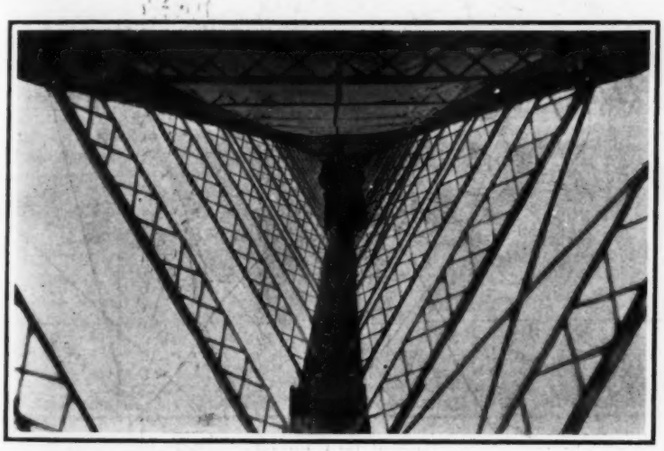
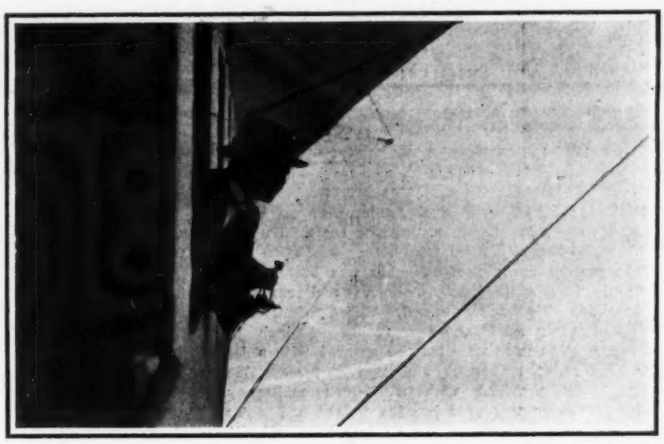
THE PARTIALLY DISMANTLED "DEUTSCHLAND" IN THE TEUTOBURG FOREST.

THE END OF THE "DEUTSCHLAND'S" BATTLE WITH THE STORM



TAKING A PICTURE ON THE PASSAGEWAY BETWKEN THE CABIN AND THE ENGINE ROOM.



PHOTOGRAPHING A PASSING LANDSCAPE FROM A CABIN WINDOW.

THE RAILWAY AT DORTMUND VIEWED FROM THE "DEUTSCHLAND."

THE VIEW AS THE DIRIGIBLE PASSED OVER THE RHINE NEAR DUESSELDORF.

THE FIRST AIR LINER.

PHOTOGRAPHS COMMEMORATIVE OF THE "DEUTSCHLAND," THE FIRST AERIAL LINER.

THE FIRST AIR LINER.

THE "DEUTSCHLAND" AND ITS ILL-FATED VOYAGE.

THE "Deutschland," (Zeppelin VII), which was built for the Deutsche Motorluftschiffahrt Gesellschaft, and which recently came to grief in a storm, was in every way a most remarkable aerial vessel.

The airship was 490 feet long and had a capacity of 24,700 cubic yards.

Count Zeppelin made up his budget for an aerial packet boat some time ago. At the time he stipulated a capacity of only 19,500 cubic yards, and a carrying capacity of 20 passengers. The cost of the airship was to be $150,000. The gas bags were to be half reinflated every week. This meant the consumption of 390,000 cubic yards of gas a month, representing an annual expenditure of $9,000; for a service of six months for fuel and lubricating oil a similar sum of $9,000 was allowed. The crew, consisting of 7 men all told, were to receive $7,500. Finally, $5,000 were to be allowed for the acquirement of aerial anchoring places. The total of the various items may, therefore, be listed as follows:

Hydrogen gas	$9,000
Gasoline and lubricating oil	9,000
Complement	7,500
Anchoring rights	5,000
Sinking fund	75,000
Total	$105,000

Besides this, there were the administration costs and unforeseen expenditures, bringing the total up to $116,500.

The passenger cabin of the ship was built of an aluminium frame lined with mahogany and rosewood, and inlaid with mother-of-pearl. The wooden walls consisted of glued mahogany veneer ¼ inch in thickness. The floor was likewise covered with a ¼-inch veneer of mahogany and was carpeted. The ceiling was provided with a ⅛-inch mahogany veneer. Veneer was used because weight had to be saved. The entire cabin was 35 feet long and 7½ feet wide, and was divided into five compartments, each containing four cane seats. These seats were of wicker, one foot being screwed to the floor so that the chair could be swung around on all sides. The entire cabin weighed only 1,600 pounds.

Besides these five compartments, each of which was 5 feet long, there was an entrance vestibule, as well as a lavatory.

The window openings were remarkably wide so that a practically unobstructed view could be obtained in all directions. The windows were not provided with glass panes. In the first compartment, however, a sliding glass window had been provided for testing purposes.

Twenty-four persons, one of them an American woman, five Germans and three Englishmen, were the first to book passages, although all were not carried along. The fare paid was $50. All told, there were 33 persons on board the "Deutschland" on her first trip.

The airship started out from Friedrichshafen at 3 o'clock in the morning, traveled up the valley of the Rhine as far as Cologne, and arrived at Duesseldorf at 3 o'clock in the afternoon, having covered in nine hours a distance of 300 miles as the bird flies. Favored by the wind, it is said at one time to have attained a speed of 50 miles an hour between Bingen and Bonn. In four hours it covered the distance from Mannheim to Duesseldorf, a distance of about 180 miles, which ordinarily requires about six hours in an express train on a rather winding track.

The "Deutschland" left Duesseldorf at 8:30 o'clock the next morning. It was a novel spectacle to see elegantly attired ladies in Indian file climbing up a ladder into the cabin. Leaving the valley of the Rhine, the "Deutschland" headed for Dortmund, a city of Westphalia with a population of 110,000 and situated 37 miles to the north. Traveling at an average height of 1,000 feet, the "Deutschland" sped over some of the most important industrial centers of modern Germany, among them the works of Krupp at Essen. The outward bound journey was accomplished in an hour. The return to Duesseldorf was less rapid and required three hours and a half. The passengers declared themselves delighted, and spoke highly of the freedom from vibration and the ease with which the airship traveled.

Encouraged by this result, the company announced voyages at frequent intervals. On the 29th of June, at 8:30 in the morning, the "Deutschland," piloted by Engineer Duerr, rose once more with 17 passengers on board, all of them newspaper representatives.

THE SHADOW OF THE GIANT ZEPPELIN VII ("DEUTSCHLAND.")

THE FIRST AIR LINER.

The voyage was to last four hours. The wind was rather strong. After having traveled for a time over the right bank of the Rhine, the dirigible was headed northward. At about 2 o'clock the city of Muenster was reached. The motors had been giving trouble and it was found that it was difficult to make much headway. The attempt was made to continue in the direction of Osnabrueck, but the fuel began to give out. At the mercy of the wind, which had risen to the velocity of a storm, the airship rapidly rose to a height of 5,000 feet. Then, suddenly, the dirigible fell with vertiginous speed. The forward motor stopped completely. There was a terrific crash. The airship had fallen in the forest of Teutoburg, 80 miles from Duesseldorf, and had been impaled on the trees. An enormous trunk pierced the floor of the cabin, to the terror of all the passengers. Still it had broken the fall of the airship and prevented a catastrophe which might have been more frightful.

The entire afterpart of the dirigible was sadly wrecked. The governing planes were broken. The envelope of the gas bags was torn in many places. The dirigible was supported about 40 feet above the ground, and rested on the trees. A company of infantry was immediately sent from Osnabrueck to saw down the trees and bring the vessel to the ground. The soldiers dismantled the dirigible and the various parts, such as the motors, the cars, etc., were packed onto railway trucks and returned to Friedrichshafen. Then the cloth covering of the airship was cut away in sections and rolled up, and afterwards the aluminium skeleton was dissected piece by piece, so that in a very few hours little remained recognizable of the aerial liner which had left Duesseldorf so proudly on the previous morning. The various parts will be utilized in the work of reconstructing the airship, which it is hoped will be ready to resume her voyages in the autumn. A good deal of the great framework is undamaged, and can be used again, as also can the greater part of the envelope. The parts of the great aluminium frame which are unusable will be melted down and recast.

Lieut. Wagner, the first officer of the "Deutschland," attributes the accident to a combination of adverse circumstances, and not to any fault of the system. The chief cause was the downward whirlwind, but if the fuel had held out the vessel would have weathered the gale. As it was, she was at the mercy of the elements. According to the recording instruments, the airship, just before the accident, was at an altitude of 5,000 feet, and in rising so high a lot of gas was lost. Then during the storm the envelope became much heavier through being drenched with rain, and thus there was a great loss of buoyancy.

GREEK LITHOGRAPHIC STONE.

EVERYBODY knows the services rendered by lithography, the art of drawing on stone of a particular character, which enables us to transfer on paper the ink adhering to the lines of the drawing, thus obtaining a reproduction of such drawing. Stone of this nature is by no means plentiful, and as a matter of fact, the almost exclusive source of supply has been the German region of Sohlenhofen. Lithographic stone is therefore very high-priced, especially the pearl-gray variety, and the one obtainable in large slabs for the impression of posters of the best quality. For this reason attempts have been made for some time to substitute some other material for lithographic stone, and comparatively recently successful results have been obtained, as regards printing and even as regards making the original drawing, with aluminium rollers and plates on which the drawing to be printed is transferred or outlined.

It is now reported that very large deposits of lithographic stone have been discovered in Greece, and more particularly in Thessaly. M. C. Mitsopoulo, professor of geology at the Athens University, and M. Tsoukala, mining engineer, have examined these de-

posits and made a careful investigation of their value. These deposits of valuable mineral are in a readily accessible valley, only a few kilometers from Pharsalus Station. All the hills of the neighborhood belong to the lime formation; the area where the lithographic stone is found is reported as about 2,000 hectares. The deposits are under strata of ordinary limestone, but outcrop at some points. Even now, it is estimated that more than one million cubic meters of this stone can be found there easily, and the thickness of the deposit is at least six meters, judging from a shaft sunk there.

The stone is found in slabs of natural cleavage, having a thickness of from 13 to 38 millimeters, which indeed is not very much; but occasionally the thickness attains 5 centimeters and over. On the other hand, the plates present very large surfaces without any cracks, and they could therefore be extracted in large pieces which could be doubled in the usual way; quite frequently plates are found which exceed one square meter without a single crack. This will not be large enough for the giant posters which are often printed in one piece, but it corresponds to the thickness of these Greek stones.—Cosmos.

THE HOOK-WORM OF INDUSTRY.

THE TWO TYPES OF ORGANIZATION.

BY HARRINGTON EMERSON.

THE poor white trash of the Southern States and the listless negroes have long been a by-word, but we suddenly find out that all these people, white and dark, are afflicted with a parasite, the hook-worm, which saps their vitality, internally slowly bleeds their strength away.

The remedy is not schools, nor churches, nor the suppression of the saloon, nor the sternness of the task master—all excellent devices; the remedy is the elimination of the parasite. After this initial betterment, the principles of education, of religion, of temperance, of stimulus, may be confidently applied.

American organization for operation, whether governmental (army, navy, civil), whether state or municipal, whether for land-railroads or ocean-steamboats, whether educational or religious, whether industrial or commercial, proves on investigation to be inefficient, often disgracefully so, the efficiency of the output of men of militia age of the country as a whole being at more than 5 per cent, the efficiency of use of materials being not more than 60 per cent., the efficiency of equipment, facilities, averaging not 30 per cent. These inefficiency statements can be verified from the facts, by any competent expert, as readily as an assayer can duplicate the assay of an ore sample.

Our material resources are unsurpassed, our workers are intelligent, ambitious, versatile, our equipment, from farm lands to office buildings, from typewriters up to Mallet compounds and down again to telephones, is lavish; yet it is all depreciated by an equally stupendous inefficiency. The principles of efficiency are simple, are plain, are elementary; they have been accepted and practiced empirically for a few million years since life began on our planet; yet in modern America, we flounder in our productive operations, as hopelessly put back in the running as the hook-worm victim in the South.

What is this insidious disease that wastes our resources of materials, of human potentiality, of equipment—that prevents the application of efficiency principles even as the existence of the hook-worm prevents the application of principles of human well-being?

The industrial hook-work disease is defective organization.

An air compressor, forcing hot and squealing air, and a vacuum pump softly coaxing cooling air, are one and the same machine working on the same cycle in opposite directions. With a very few simple changes the compressor can be changed into the vacuum pump. So with a very few small changes a disastrous form of organization can be turned into a beneficent form.

In primitive times, with that fatuity and perversity which unaccountably characterizes so much that is human, we turn to the left when we ought to have turned to the right. Having two forms of organization to choose from—only two, the destructively offensive and the constructively defensive—we choose for our industrial organization the destructively offensive type, and it does not work out, never can and never will; while we ought to have chosen the constructively defensive type of organization, alone suited to productive upbuilding.

The two types of organization are as old as life, are therefore far older than humanity, and we have had to accept them as part of our inheritance just as we accept the necessity of assimilation, of elimination, of reproduction, of breathing. But there is no more reason in adhering industrially to the destructive type of organization, since we have learned that the other is better, than there is in adhering to pack teams and ox carts after the railroad and automobile have been perfected.

To bring out clearly the radical differences between the two types of organization, in spirit, in effectiveness, and in methods, we select two primitive examples, one a plant and the other an animal. The plant trusts to the generous, often enthusiastic co-operation of forces outside of itself and it therefore draws strength of wide and unlimited range. The mammal trusts to the occasional, often grudging, co-operation of powers identical in kind with its own, therefore of limited scope. The pathfinder through primeval forest is impressed with the luxuriant wealth and profusion of plant life—trees, at their best, 400 feet high; is impressed with the comparative paucity, pettiness, transitoriness of animal life, whose largest jungle representative is the elephant, twelve feet high and living at most a few hundred years. Plants trust all nature and draw help from everywhere; animals trust none but their kind and grow through destruction. Even that type of all that is silly and innocent, the sheep, will destroy in a few years a millennial pasture range.

The wild rose bush exemplifies the defensive, upbuilding type, of organization. The rose stems are covered with sharp thorns so that the delicate flowers may not be plucked and destroyed by wanton creatures who might just as well be browsing on grass or leaves, but the color and perfume of the blossoms attract the bees, beetles, butterflies, and moths who in return for an efficiency reward, the honey, cross-fertilize the plants. The petals fade and drop, the seed receptacle, an inconspicuous green, swells and grows. When ripe, the leaves that hid it fall away; it appears red, a tempting rose-apple to bird that plucks it, to mammal that finds it dropped, but the cradle of the seeds is so protected that the rose babies escape to grow and flourish where they fall. The rose relies on defensive up-bulding organization, calling on water, air, warmth and light, earth, insects, birds and mammals, each taking a part, all helping the rose to dot the western prairies, to deck the roadside and moors of the New England seaboard, to blanket the lovely North Pacific Coast.

Roosevelt gives us the other picture when he describes the African baboons who are organized for offense, for destruction:

"The baboons were very numerous around this camp, living both among the rocks and in the treetops. They are hideous creatures. They ravage the crops and tear open new-born lambs to get at the milk inside them; and where the natives are timid and unable to harm them they become wantonly savage and aggressive and attack and even kill women and children. In Uganda, Cunninghame had once been asked by a native chief to come to his village and shoot the baboons, as they had just killed two women, badly bitten several children, and caused such a reign of terror that the village would be abandoned if they were not killed or intimidated. He himself saw the torn and mutilated bodies of the dead women; and he stayed in the village a week, shooting so many baboons that the remainder were thoroughly cowed."

Baboons do not act singly, but in bands with leaders, with sentinels posted. Baboons, wolves, wild dogs, and primitive man are thoroughly organized for offense and destruction. It is because the object is offense and destruction that evil characteristics are most prominent—arbitrariness, irresponsible exercise of power, harshness, cruelty, with anarchy all along the line.

Some strong male, differing not in kind but merely in degree from his fellows, has fought his way to the top, is given allegiance, based partly on fear, partly on self-interest. He delegates power, or each lower rank of followers usurp power, and this results in anarchy all along the line. Are we now writing of the African baboons, of the wolf pack, of the paleolithic war chief, of the neolithic hunting, foraging, plundering, filibustering chief, of the enterprising New York Madagascar trader, of the respectable Rhode Island slave and rum trader and privateer; or are we writing of Roosevelt's land and marine experiences as a Rough Rider with our army and navy; or are we writing of the shops of the great industrial incorporations, of the operation and maintenance of our railroads? It is all one and the same thing, as they are all victims of a common type of organization resting on the same principles—individual arbitrariness at the top, usurped and delegated power down the line, anarchy everywhere.

Modern men have lost the fangs and the cruel hands of the baboon; in them also his savage, cruel instincts are softened. Modern sea captains are not such monsters of cruelty as Henry Morgan, modern generals are not as ruthless as Cæsar, Attila, Genghis Khan, Tilly, or even Napoleon. Men, thoroughly good, conservative, upright men, with every great upbuilding instinct, are happily at the head of most of our great institutions; they are infinitely better than the destructive organizations through which they are compelled to work, knowing no other; but the old danger is always latent. We who know could fill volumes with modern illustrations of the ever out-cropping evils due to the destructive type of organization.—Engineering Magazine.

A NEW MICROPHONE.

A NEW microphone has been patented by the Berlin house of C. Lorenz; it differs from all previous constructions by the use of a substance which is heat-resisting and a good conductor of electricity and exhibits considerable variations of electrical resistance, even with very slight pressure oscillations.

It is well known that of all solid substances suitable for use of microphone contacts, carbon has yielded by far the best results. Its use, however, offers the serious drawback that under the influence of the electric current the sensitive contacts gradually become reduced to ashes, so that carbon microphones, after more or less time, become less efficient or even entirely unserviceable. This effect is particularly disturbing when high tension currents are used. For this reason the employment of carbon in microphones intended to operate with currents of high intensity has been possible only, thanks to the use of special cooling arrangements, and even then only within rather restricted limits.

In the new type of microphone, instead of the pure carbon used hitherto in the manufacture of sensitive contacts, there is employed a carbon modified chemically by a special treatment. Experiment has shown that carbon silicide (silundum), produced by heating carbon to incandescence in an atmosphere of highly heated silicon vapor, is particularly suitable for this use. Such carbon silicide is much more refractory than ordinary pure carbon. Owing to this characteristic, it enables speech to be transmitted much more efficiently than with the usual devices. The microphone efficiency of silundum remains high even when currents of extraordinary intensity are employed. This new material, therefore, can be used for ordinary microphones and also for microphones operated with currents of great intensity.

Thanks to the readiness with which this material can be reduced to the form of powder, granules, globules, rods, etc., the manufacture of a sensitive contact becomes very convenient, the more so since the microphone diaphragm can be prepared readily with the same material.—Cosmos.

It is pointed out that M. Paulhan's time for his great flight from London to Manchester was considerably less than that of the average train, and only 41 minutes more than that of the fastest express now running, as the following figures show. Average time of sixteen regular daily trains, 4 hours 28 minutes; the fastest express journey, 3 hours 30 minutes; M. Paulhan's actual time in the air, 4 hours 11 minutes. A London and North-Western train was in attendance on M. Paulhan throughout his journey, the route of which was practically identical with that of the company's line from London to Manchester.

SAFE SHIPMENT AND STORAGE OF EXPLOSIVES.*

DYNAMITE AND THE COMMON CARRIER.

BY B. W. DUNN.

A RESPONSIBILITY to the public rests upon both manufacturers and common carriers to secure the safe delivery at destination of explosives, and it is the duty of the owners of explosives to store them safely.

Under authority granted by Congress, the Interstate Commerce Commission has made regulations, binding upon shippers and common carriers, for the transportation of explosives in interstate commerce, and the penalty of a possible fine of $2,000 and eighteen months' imprisonment is prescribed by law for a violation of any of these regulations.

The shipper must know and certify on his shipping order that the explosive offered by him is in a proper condition for safe transportation and that it is packed and marked as required by the regulations. To perform this duty the shipper should be thoroughly familiar with all requirements pertaining to his shipment. A copy of the regulations can be obtained by application to the railway agent, whose duty it is to furnish them to shippers.

The following paragraphs in these regulations are of special interest to the shipper of explosives used in mines: *General Rule A.*—Paragraphs 1501, 1502, 1503, 1509, 1510, 1531, 1533, 1541 to 1556, 1558 to 1560, 1611 to 1614, 1648, 1661, 1665, 1666, 1668, 1674 to 1683.

Miners and other persons are sometimes tempted to pack explosives for shipment with their baggage on passenger cars, or with their household goods for shipment by freight. To do this is a criminal act that may endanger the lives of the innocent and unsuspecting persons who have to handle these packages, and that will subject the guilty shipper, when detected, to arrest and prosecution. The federal law (section 236) prescribes an imprisonment of ten years for any one convicted of this crime when death or bodily injury results from the illegal transportation of explosives. When no injury results, the maximum penalty is eighteen months imprisonment and a fine of $2,000.

There is no standard type of storage magazine in use in this country, and the laws and regulations in foreign countries applicable to the construction of magazines differ materially. In Austria, for example, they are required to be of light construction, while in England they must have walls at least 18 inches thick.

Explosives should be protected as far as practicable during storage against heat, moisture, fire, lightning, projectiles, and theft. The buildings should therefore be weatherproof, covered by fireproof and bullet-proof material, well ventilated, in secluded locations, and not beside grass or underbrush subject to fire risk. Lightning protection is best placed on a line of supports encircling the building and 20 to 30 feet distant from it. Figs. 1 and 2 show plans of an approved type of magazine.

It is difficult to state definitely safe distances to separate magazines from dwellings, highways, railroads, etc. The proper distance must vary, evidently, with the amount of explosives stored and the degree of natural protection afforded by the slope of the ground and of artificial protection, such as barricades or mounds of earth.

The distances prescribed by the English law have been adopted by the State of Massachusetts. They are materially greater for large quantities of explosives than those prescribed in other countries. For example, the distances from a railway or public highway prescribed for a magazine containing explosives without natural or artificial protection are: For 1,000 pounds—England, 630 feet; Prussia, 984; Austria, 984; Italy, 244; for 10,000 pounds—England, 795 feet; Prussia, 1,968; Austria, 1,640; Italy, 328; for 80,000 pounds—England, 2,160 feet; Prussia, 1,968; Austria, 984; Italy, 574.

These distances may be materially reduced, in some places to one-half or even to one-quarter, where there is good natural or artificial protection.

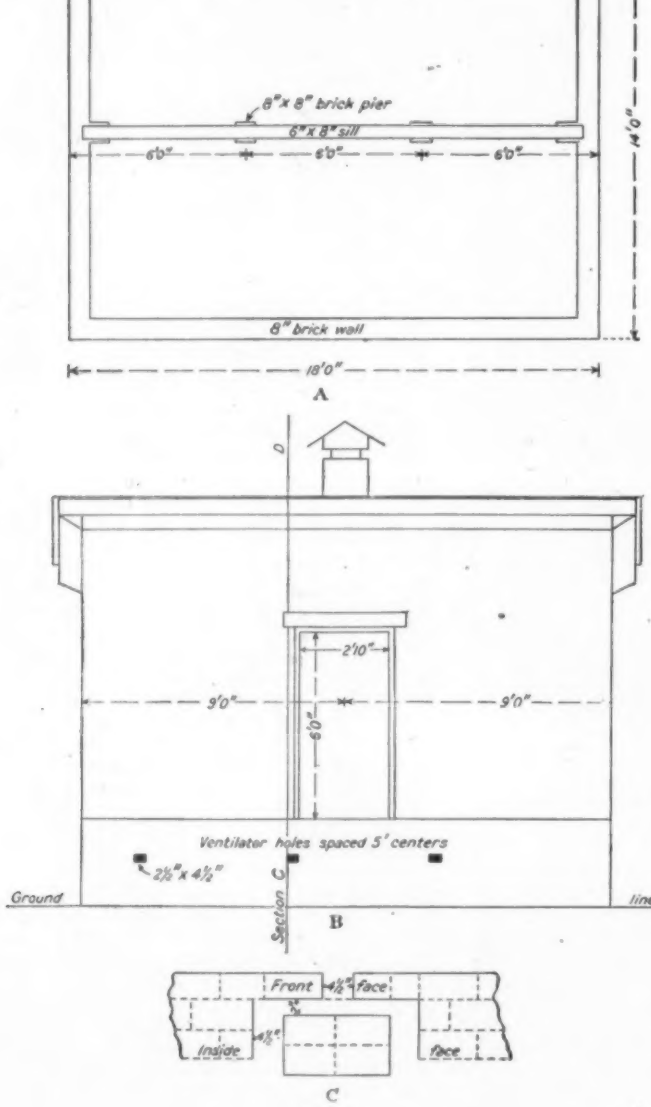


FIG. 1.

Foundation plan (A), front elevation (B), and plan of ventilator hole (C) of brick magazine.

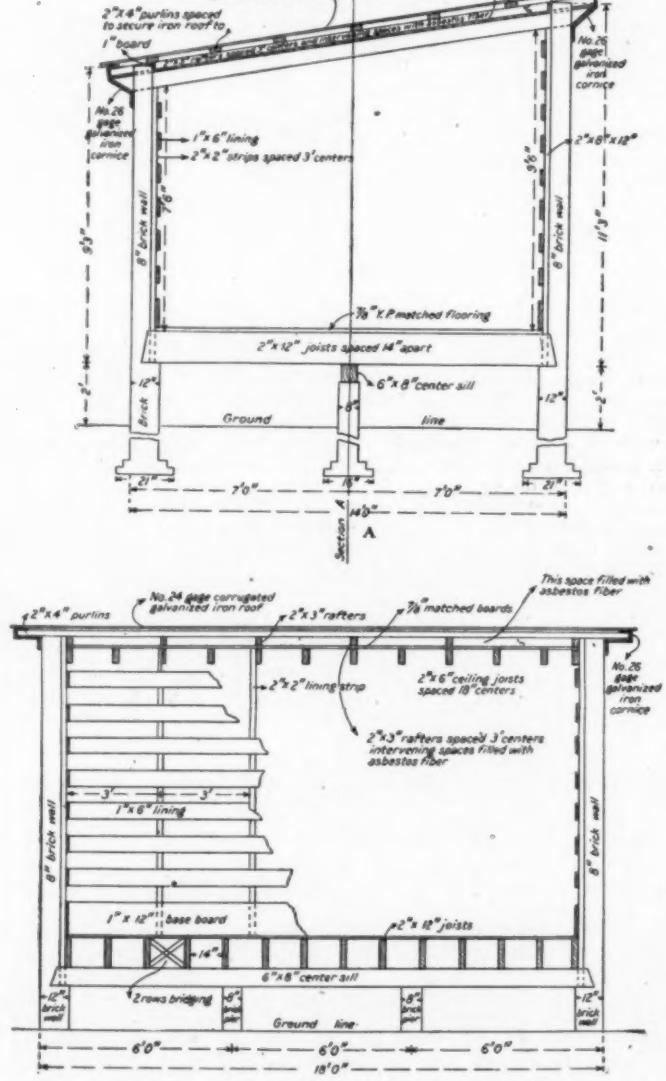


FIG. 2.

Sections of magazine: A, section of line *C D* in Fig. 1 B; B, section at line *A B* in Fig. 2, A.

Magazines should be kept clean and in thorough repair. Grounds around them should be kept clear of leaves, grass, or other materials that might feed a fire. These words should be conspicuously posted on them: "Explosives—dangerous. No shooting allowed." The floors must be swept regularly and kept clean. The sweepings should be thrown in water or taken to a safe distance and destroyed.

In case floors become stained with nitroglycerin, cover the stains with dry sawdust, sweep up, and remove the sawdust. Then scrub the stains thoroughly with a hard brush and a solution of one-half pound of sulphide of sodium or sulphide of potassium in one-half gallon of wood alcohol.

Do not allow in the magazine any tools other than a wooden mallet and wooden wedge, or a phosphor-bronze chisel, and a screw-driver to be used only for removing screws.

Do not open dynamite boxes with a nail puller or powder cans with pickaxes.

Remove all explosives before repairing a magazine.

* Abstracted from Bulletin 429 U. S. Geological Survey.

Do not store detonators with explosives, especially high explosives.

Do not open packages of explosives in a magazine.

Issue first the oldest explosives on hand.

Do not store dynamite boxes on end, as this increases the danger of nitroglycerin leaking from the cartridges.

Persons receiving packages of explosives sent by rail should examine them carefully to discover ruptures or other serious damage during transit. Any information regarding such matters will be welcomed by the Chief Inspector, Bureau for the Safe Transportation of Explosives, 24 Park place, New York city.

THE EGG-SHAPED OVAL.

THE GEOMETRY OF A LITTLE UNDERSTOOD CURVE.

BY FRANK McLEES.

CONSIDERED geometrically the oval is a curve that appears to have no acknowledged place in any of the curve groups. It is not included in the list of conic sections, and the books on geometrical drawing dismiss the figure with a poor attempt to construct it by means of circular arcs, the result being far from satisfactory. The writer has searched the English speaking authorities in the New York Public Library and has submitted the problem to mathematicians in the effort to find a way to generate the curve shown by a longitudinal section of the hen's egg. The search was not successful. A highly mathematical treatise on the Cartesian Ovals, the only work in which ovals were mentioned, did not throw any light on the question.

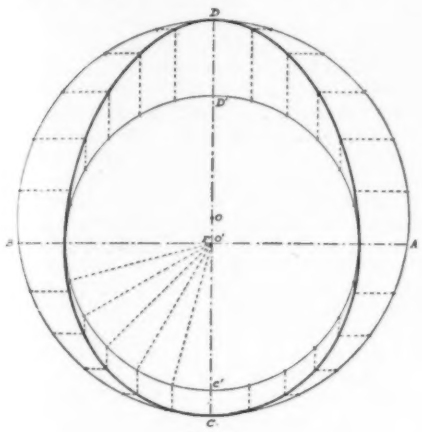


FIG. 1.

It became necessary to make experiments, as it seemed reasonable that a curve so common in nature must be easy to construct under geometrical laws. The difficulty was to find a method. Beginning with a well known and universally taught method of constructing the ellipse by means of two concentric circles and radiating lines, and modifying it by moving the center of the small circle a short distance away from that of the larger one the first experiment produced gratifying but not entirely satisfactory results. Fig. 1 will serve to illustrate. The center of the lesser circle was taken as the focus for the radiating lines and the points found in the usual manner. This made the base of the oval too nearly circular. The next trial was no better in its results. In this the center of the larger circle was taken as the focus, but there was no very marked difference in the curve. In the third attempt the circles were arranged as in the first two trials, but the focus was moved to a point on the axis below the other two central points. This curve was too nearly an ellipse, although it was sharper at one end than at the other. By taking the focal point above the two centers, i. e., to a position between the center of the large circle and the pointed end of the oval (Fig. 2), the oval became much more sharply pointed, but the base was still too circular.

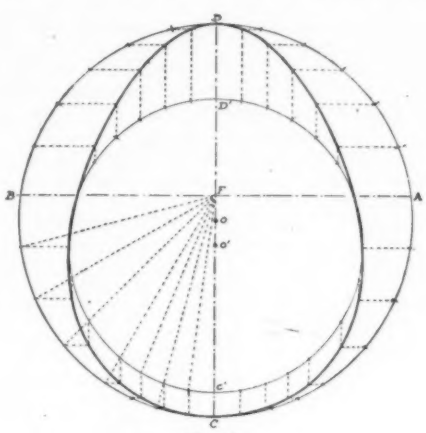


FIG. 2.

There seemed to be no hope of perfect success with the circles drawn from different centers, so a trial was made of concentric circles and an eccentric focal point. This gave very much better results and a series of experiments along this line culminated in Fig. 3, in which the oval is really shaped like an egg.

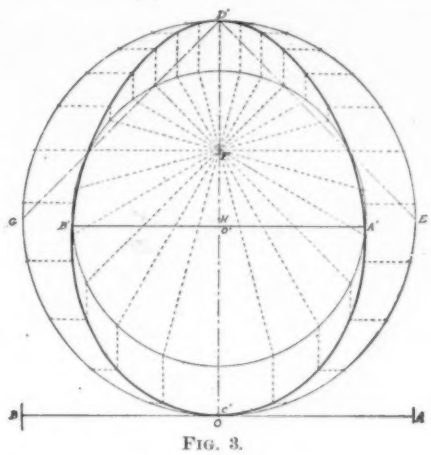


FIG. 3.

The fact that the oval is sharper at one end and broad at the other end suggested that there must be a triangle among its "ancestors" and further experiment gradually evolved the method illustrated in Fig. 4, which is the perfect method of generating the oval. It is simple, easy to understand and requires only a pair of compasses, a ruler and a pencil to execute it. From O as a center, draw a circle whose diameter AOB is equal to the major axis $C'D'$ of the desired oval. Erect an isosceles triangle FAB having for its base the diameter AOB of the circle. Draw the axis of the triangle FC. On the semicircle below the base lay off any number of points (a', etc.). These need not be equidistant. Connect the vertex of the triangle with each of these points by a straight line (Fa, etc.). Draw tangents FT, FT. Connect the sides of the triangle by a line $A'O'B'$ parallel to the base and equal in length to the given minor axis.

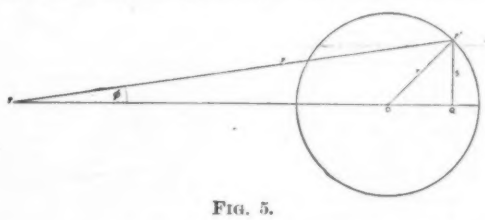


FIG. 5.

Set the compasses to the distance AA' on the line AF. From every intersecting point $ABCD$, $TP'a$, etc., on the circle lay off point AA' distance on the radiating lines measuring toward F in each case. The points so found are points on the oval.

The proportions of the oval depend on its location in the triangle. As the point C' is brought nearer to C the oval becomes rounder and broader until at the coincidence of C' and C it is a circle. On the contrary, as the point D' approaches the focus F the oval becomes narrower and more pointed until the coincidence of F and D' produces an oval node.

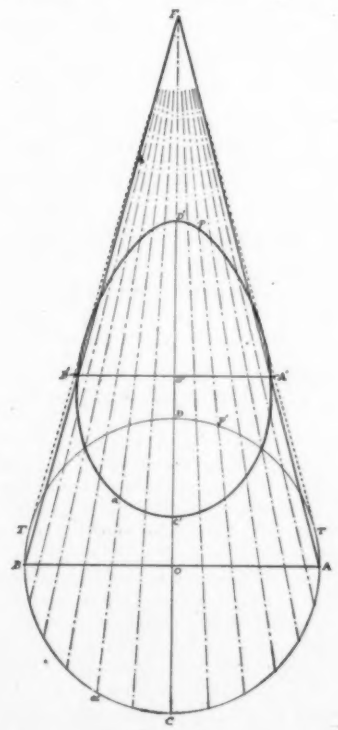


FIG. 4.

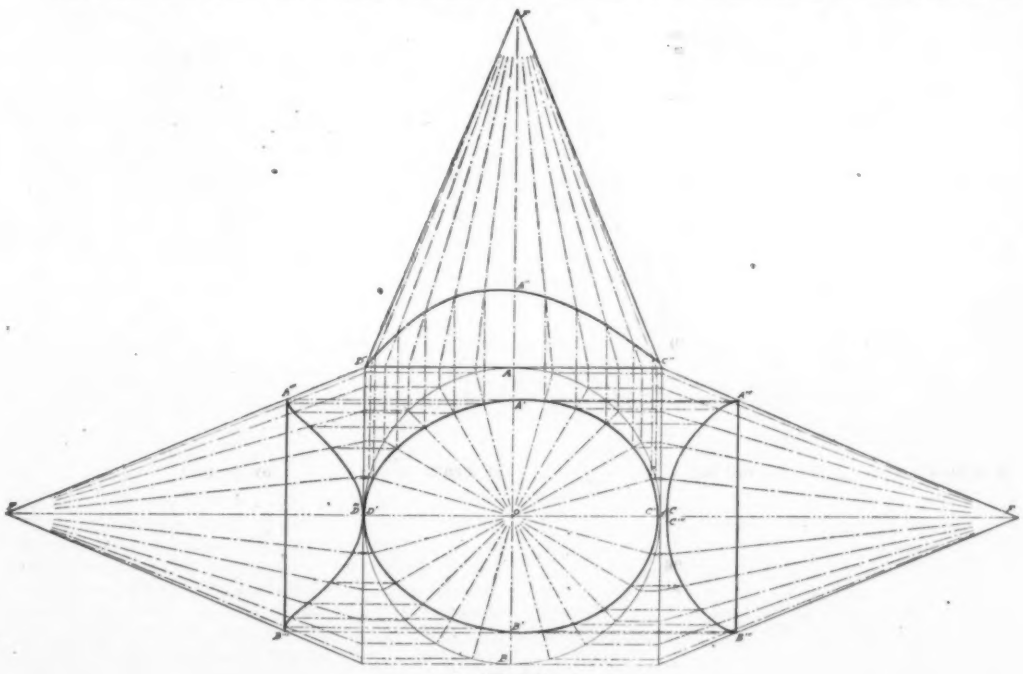


FIG. 6.

Many curiously proportioned ovals may be found by producing the focal radii above the vertex or below the base of the triangle, but without changing the size or location of the circle of origin, and laying off the points for the oval in either of these positions.

If the focal radii are produced beyond the focus F, and a greater distance than FD, but less than FC, is taken in laying off the points from the circle, the figure produced will be a lemniscate. If a greater distance than FC is taken, the figure will be an inverse oval becoming greater on the axis $A'B'$ as it recedes from F. In all of the figures having the same circle of origin the diameters or axes lying in the direction OF will be equal regardless of variations in the altitude of the triangle, i. e., $CD = C'D'$ constant.

An oval then may be defined as the focus of a point P lying in a straight line between a fixed point or focus F, and a point P' moving in a circular path, the distance PP' being constant.

The point O' at the intersection of the two axes of the oval is the true center of the oval. It is found by taking PP' distance from A and B and joining the points $A'B'$ so found on the oval.

Both tangents (shown dotted) are tangent to any oval constructed in this triangle from the same origin.

The distance PP' may be any distance, not greater than FD, to generate a true oval. If PP' is greater than FD the figure will be either lemniscate or inverse-oval.

Equation of the curve as worked out by Prof. W. G. Hawley, of Scranton, Pa., is as follows:

Given the points F and O fixed (Fig. 5) to find the equation of the curve described by P ($PP' =$ constant) as P' moves around the circle.

P is the straight line FP'.

$$\text{Let } FO = b$$
$$PP' = a$$
$$FP' = \rho$$
$$\text{angle } P'Fo = \phi$$

$$\text{Then } \cos\phi = \frac{b + OQ}{\rho}$$

or

$$\rho \cos\phi = b + OQ$$

but

$$OQ = \sqrt{r^2 - s^2}$$

and

$$s = \rho \sin\phi$$

hence

$$\rho\cos\phi = b + \sqrt{r^2 - \rho^2\sin^2\phi}$$

or

$$\rho^2\cos^2\phi - 2b\cos\phi + b^2 = r^2 - \rho^2\sin^2\phi$$

arranging and solving for ρ we have:

$$\rho = b\cos\phi \pm \sqrt{r^2 - b^2 + b^2\cos^2\phi}$$

which is the equation of the circle; polar co-ordinates, center at F, therefore

$$\rho = b\cos\phi \pm \sqrt{r^2 - b^2 + b^2\cos^2\phi - a},$$

is the equation of the locus of ρ according to given conditions.

If a cone is cut by a plane to generate a closed curve the result is either a circle or an ellipse. The egg-oval is the projection upon a plane of a *curved* section of the cone. This is clearly shown in Fig. 6. The oval $ABCD$ is revealed by a section of the cone made by a straight line parallel to the base at every point and moving in a curved path $D''A''C''$ Fig. 6. Three views are shown. $D''A''C''$ is a view from the side B. $A'''D'''B'''$ is a view from the side D; and $A^4C^4B^4$ is a view from the side C.

COMBINED TURBINES AND PISTON ENGINES.

HARDLY are the results of the first turbine steamer with mechanical gearing available than the attention of nearly all the leading firms in the country is directed to the use of the combined system of turbines and reciprocating engines by the simultaneous inquiries of the Cunard and Orient Steam Navigation Companies for new steamers, for which, while reciprocating engines are specified, alternative designs are desired embodying a similar system to that fitted in the "Otaki" and the "Laurentic." The fullest data have been published by the builders relative to the comparative trials of the former vessel and her sister ship, and while little has been said about the latter, it is an open secret that her performance is at least equal to that of the other. That more would have been heard of the combined system ere now is certain but for the tremendous pressure on all parties concerned, due to the rapid development of turbines only for high-speed work. That comparatively little may be heard in future is not at all improbable if the durability of mechanical gearing or the efficiency of a hydraulic system can be proved.

As usual, the problem of the application of this new arrangement of engines is a double one. In the first place, the owners will require most definite assurances regarding the question of economy in order that they may determine the financial value of a scheme that is certain to involve a greater capital outlay, while in the second place, the technical difficulties in the way of the designers are considerable. In the case of the last batch of Orient liners, built a year or two ago, the average coal consumption on the economy trial was only 1.19 pound per one horse-power per hour, the vessels, of course, being fitted with quadruple expansion reciprocating engines. The steam consumption must consequently have barely exceeded 13.0 pounds per one horse-power for main engines only, even if we credit the boilers with an evaporation ratio of 12. The Hon. C. A. Parsons' estimate of 11.45 pound per one horse-power of the combined system, as given in his paper read before the Institution of Naval Architects in 1908, was shown to be no idle guess in the trials of the "Otaki," and represents a saving of about 12 per cent. The average coal bill at about 16½ knots of the Orient boats referred to is about 120 tons per day for all purposes—say 105 for main engines only. Twelve per cent of 105 tons is only 12.6 tons per day of actual steaming; this, in fact, is the gain per day possible off the existing vessels which is available for paying off the increase of capital cost due to the more expensive combined installation. Assume 250 days' steaming during the first year, and there is a saving of no less than 3,150 tons—maybe at over £1 a ton—to counterbalance the increased loss of interest and depreciation; making all allowances for the necessarily approximate nature of such a calculation, this shows that the financial side of the combined system might easily possess very great attractions. Compared with the best triple-expansion engines the figures for the combined system are even more favorable.

For the Cunard vessels the service conditions lend themselves rather better to the economy of the turbine than is the case on the Orient service, where the vessels are, for over a fortnight in each direction, in sea water of extremely high temperature. With modern condensing plants the temperature of the circulating inlet water is of paramount importance, and cooler water obviously prevails in the Cunard Atlantic service than between Suez and the northwestern side of Australia. It is, however, possible and practicable to attain with properly proportioned plants a vacuum exceeding 93 per cent of the barometer, with circulating water exceeding 80 deg. F. in temperature, but large pumps must be provided. Inside the vessel the crux of the situation lies in the thermal conditions between which the engine and turbine must work, and especially in the dividing line between them and also at the turbine exhaust. The difficulties to the designer are greater than those of the financier at present, because not only is the pressure at the engine release a somewhat doubtful factor, but outside the vessel the relative sizes and positions of the propellers are extremely difficult to determine. Insufficient experience is available on the subject. Assuming that a vacuum of 28 inches is decided on, and that it has been arranged to run the turbine at a point of high economy, the higher the pressure the more, obviously, will be the horse-power developed on the shaft. The objection to increasing this is the limit advisable for the diameter of the center propeller at one end, and, at the other, to the increasing back pressure on the engine. In the case of a vessel which is run continuously at or about her designed speed an initial pressure of not less than 7 pounds absolute at the turbine appears most suitable, but if, especially as is the case with boats like the Orient liners, a considerable portion of the voyage is made at a reduced power, then it is desirable to design the turbines so that the pressure shall not fall below 7 pounds absolute under the lower conditions of power. Probably there is little appreciable effect on the overall economy if the inlet pressure is carried up to atmospheric pressure as far as ahead running only is concerned; but the turbine is not reversible, and for working astern a high back pressure, by its effect on the size of the cylinders, curtails the reversing power. In the "Otaki" at full power the inlet pressure was about 10 pounds absolute; in the "Laurentic" it is rather higher. Only a short analysis of the various combination arrangements of machinery is sufficient to demonstrate clearly which is the most suitable for marine propulsion. In nearly all cases the most suitable arrangement will be found to be that with two reciprocating engines in the wings and a central turbine doing between a third and a half of the work. A central engine and two wing turbines is permissible under certain circumstances, but its cost will be greater, and it possesses the practical disadvantages of only having the central engine reversible, unless reliance be placed on astern turbines, which seems a needless complication. If two wing engines are to be reduced in size by about a third, it seems very reasonable to introduce higher revolutions. Why not go a step further and introduce forced lubrication engines and even higher revolutions? The rotary speed of the new Orient liner is 81 revolutions per minute; the engines are about 60 inch stroke, so that a piston speed of over 800 feet per minute is contemplated at 17 knots speed. With the smaller engines—the proposed quadruple machinery involves 84 inches low-pressure cylinders—it should surely be possible to run at 100 to 110 revolutions. Marine superintendents probably hardly realize the reliability of the more recent Admiralty reciprocating engines. Yet the "Minotaur" crossed the Atlantic at 21 knots after the Quebec review last year, and there is ample Admiralty experience of the forced lubrication system to justify its adoption for 100-110 revolutions. This is not a great increase over the trial revolutions of the "Osterley" class, which were in the nineties, while the "Africa" and "Minotaur" classes in the Royal navy exceed 130, and are of double and treble the power respectively. The revolutions in the "Otaki" were over 100 at full speed, and averaged 81 on a non-stop run exceeding 11,600 miles on her first voyage, which was at 11 knots instead of at her trial speed of 15. It is impossible to avoid the feeling that mercantile marine engineers are not making the most use of the advantages of forced lubrication.

Again, disregarding the revolutions of the reciprocating engines, what is the best type of engine to use? Is it to be compound, triple or quadruple? It depends entirely on the initial pressure at the turbine, and the consequent percentage of power it is desired to develop therein. Model experiments have shown that under different forms of stern lines it is sometimes advantageous to increase relatively the turbine power on the center shaft. We have not only to consider the thermal efficiency of the engine, but we have to consider its mechanical efficiency as well, and this is undoubtedly influenced by the complexity for a given power. It is extremely probable that if for any reason it is desired to exceed an initial turbine pressure of 15 pounds absolute, compound engines with three cylinders will be found most suitable, not only from the point of cost, but of efficiency. The quadruple engine seems to be out of the question entirely, as the turbine is expressly designed to be its low pressure cylinder, but it is a doubtful point, depending chiefly on the initial pressure at the engine as to where triple or compound engines should be used for cases when the initial turbine pressure is between 10 pound and 15 pound absolute. The temptation to hope for greater economy is balanced by the desire to produce the cheaper engine.

Though the great superiority of the combination system as regards economy of steam consumption need not be doubted as regards piston engines, it remains to be seen whether a geared system of turbine propulsion will not prove superior to the combined type. It certainly looked at first sight as if mechanical gearing would consign the combined system to a species of commercial oblivion. The Melville gearing has run for months—turbine driven—with a unit even more powerful than the reciprocating engines which are proposed for the boats under discussion. In such a case one would obtain the most efficient twin screws without the risk of marring the thermal result of a combination set by a lower propeller efficiency, while the turbine could be run under conditions peculiarly favorable to the highest efficiency. It will be in the highest degree interesting to see whether both or neither of the two great ship-owning companies adopt the older engine, or, basing their judgment on what certainly are the remarkably economical propulsive achievements of the only two large merchant vessels whose results are available, will they adopt the newer system? In any case it appears highly probable that the combined system will have a most formidable competitor in the geared turbine for all types of ship.—The Engineer.

ELECTRO-PLATING ALUMINIUM.

IN a note headed "Electro-plating Aluminium," which recently appeared in the Electrical Review, it is stated that it has hitherto been found impossible to produce a lasting coat of metal on aluminium for the purpose of protecting the latter against attack by alkalis such as salt, saltpetre and soda. Many patents have been taken out on the subject, but none of them have led to practical results—the coating in all cases flaked away in time. It has been found by a firm in Berlin that this behavior is owing to the presence of a coating of oxide on the aluminium, and that if this oxide is first removed, aluminium behaves like other metals, and allows itself to be permanently coated with copper, nickel, silver or gold without difficulty. The firm has discovered a simple way of removing the oxide from the aluminium, and has thus been able to produce very good and permanent coatings. For instance, some aluminium spoons coated by this process were boiled for eight hours in a 3 per cent solution of caustic soda, and then allowed to lie in the cold solution for another 36 hours, without any signs of flaking, although at places where the coating had been previously intentionally removed the aluminium was completely eaten away. This test compares with the treatment which household articles would meet with in a year and a half or two years of washing with soda, etc. Several firms have taken out licenses for the process, and electro-plated aluminium articles will shortly be on the market.

LIGHT AND ELECTROMAGNETISM.*

ELECTRIC WAVES AND THE ELECTROMAGNETIC THEORY OF LIGHT.

AS THE subject of his present course of lectures at the Royal Institution, Sir J. J. Thomson has chosen that of electric waves and the electro-magnetic theory of light. The first of the series was delivered by Sir Joseph on February 12th.

In opening his discourse, Prof. Thomson said that he proposed to consider in the first place the properties of electrical waves, and afterward to pass on to the electro-magnetic theory of light. In this latter theory light was regarded as an electrical phenomenon and light waves as electrical waves. The discharge of the Leyden jar, he continued, was the best way of producing electric waves. Up till seventy years ago physicists were quite satisfied that they knew all about such discharges. According to them the theory was simple. When the jar was charged there was, say, positive electricity inside, and negative on the outer coating. On connecting the two coatings by a wire it was thought that all that happened was that positive electricity flowed through the wire in one direction, and negative in the other, the two charges simply neutralizing each other. This was the view universally held up till 1840, when Prof. Henry, of Princeton University, a man of great insight and originality, made certain experiments on the demagnetizing of needles by the discharge from a Leyden jar. This discharge was effected by a current through a connecting wire, thus producing a magnetic force capable of demagnetizing a steel needle.

Sir Joseph said that he would try and repeat one of Henry's experiments, which had led that observer to doubt that the ordinary view at that time as to the discharge of a Leyden jar was quite inadequate. In this experiment two needles magnetized to saturation were placed in the neighborhood of the wire through which the discharge of the jar was effected, being arranged so that similar poles pointed in opposite directions. If the current on the discharge flowed in one direction, its magnetic field would have no effect upon one needle, since that was already saturated, while it would tend to demagnetize the other. In actual fact, however, it was found that both needles were demagnetized, but one to a greater degree than the other. In the demonstration of the experiment by Prof. Thomson, one needle, when tested, proved to be nearly wholly demagnetized, while the other had its original magnetism much weakened. On the old theory as to the discharge of the jar, this fact constituted, he said, a mystery. Henry accordingly made a whole series of experiments showing the most remarkable insight, and in a paper published in 1842 stated definitely that the phenomena were such as to lead him to admit the existence of a primary discharge in one direction, and then a series of reflex actions backward and forward until equilibrium was established.

As further evidence of this oscillatory discharge, Prof. Thomson showed that with a vacuum tube charged with neon, and subjected to a discharge constant in direction, there was a great difference in appearance between the ends of the tube, one electrode being surrounded by a bright yellow glow, while at the other there was a mere speck of light. When, however, a jar was discharged through such a tube, the yellow glow was seen at both ends, the two appearing symmetrical. Hence, as concluded by Henry in 1842, the current, when a jar was discharged, oscillated backward and forward. Henry's work, being published in magazines of small circulation, attracted little attention; but, with the audacity of genius, Helmholtz, though ignorant of Henry's work, and having made no experiments in the matter himself, in his 1847 paper, on "The Conservation of Energy," stated boldly that he would assume that the discharge of a jar was not a simple flow of current in one direction, but an oscillation backward and forward. He had, in fact, no doubt about the matter, and did not need to experiment. Next, Lord Kelvin, in 1853, showed on electrical principles that the discharge must be of a backward and forward character. He could not, the lecturer continued, enter into the mathematics of the subject on that occasion, but he could give an idea of the principles which would lead them to expect this conclusion. A jar, charged to begin with, had potential energy, since sparks and heating were produced on its discharge. In other words, the electricity in the jar possessed energy in virtue of its position. If the two coatings were connected by a conductor, the electricity moved along the wire, and there was thus a current. Electricity in motion also possessed energy, which was converted into heat as the current gradually died away. When the jar was discharged, therefore, the energy of the electricity due to its position was converted into the energy of the electricity in motion, and as the charge disappeared the whole of the original energy became that due to the motion of the electricity along the wire. Whenever such a transformation of potential into kinetic energy took place, the process did not cease with the disappearance of the potential energy, but the kinetic tended to flow back into potential, to be followed by a re-conversion into kinetic, and so on, each in turn flowing back into the other. The system was, in fact, equivalent to a U-tube, having bulbs at each end, and nearly filled with liquid. When the level was disturbed, so that it was higher in one bulb than in the other, liquid flowed through the tube and restored the level; but it did not stop there, the flow continuing so as to raise the level in the second bulb, which in turn gave rise to a reversal of the flow. The fluid swayed accordingly backward and forward, being first higher in one bulb and then in the other. Kelvin's investigation was based on the foregoing lines, and he actually found an expression for the time of one oscillation.

Visual proof of the oscillatory character of the discharge, the lecturer proceeded, was afforded by a famous experiment of Feddersen, a modification of which he would, he said, exhibit. The difficulty of obtaining direct evidence of the oscillatory character of the discharge arose from the immense rapidity of the oscillations. It was in fact a matter, not of hundreds a second, but of hundreds of thousands or even millions. No ordinary indicating instrument was therefore able to follow the motion of the current. A galvanometer, for instance, was so distracted by the advice given it to move first one way and then the other, that its needle remained stationary. If the discharge were visible, however, it was obvious that the light would wax and wane with the current. If viewed direct, however, the retina merely averaged out the successive impressions; but if it were observed in a rotating mirror, the intermittent character of the discharge became obvious. The mirror having moved between successive discharges, a succession of bright and dark bands was observed, as the lecturer proceeded to demonstrate, using a neon tube for the passage of the discharge.

Reverting to the analogy of the oscillations of a liquid in a U-tube, the lecturer remarked that on using a very viscous liquid, such as treacle, the levels gradually settled down without oscillations, and one got a condition corresponding to what the older physicists thought always occurred on discharging a Leyden jar. If, again, the latter were likened to a spring, it was known that if such a spring were compressed and then let go, it would oscillate. But were it immersed in a very viscous fluid its motion would be dead beat, and on release it would merely creep back to its zero. It was possible to put into the discharge circuit of a Leyden jar something that corresponded to the friction of the viscous fluid in the above cases, and then the appearance of the discharge, as viewed in the rotating mirror, was entirely altered. This the lecturer showed by including a length of wet string in the discharge circuit.

Another method of establishing the oscillatory character of the discharge, Sir Joseph went on, made use of the principle of resonance, first applied to this end by Sir Oliver Lodge. The lecturer showed an apparatus comprising two condensers, each consisting of two parallel plates separated by an air-gap, and each coupled up to a rectangular metallic circuit. The two rectangles were arranged opposite and parallel to each other. One of the condensers was coupled up to a coil, and discharged itself through its rectangular circuit. The other had, included in its circuit, a neon tube, and was arranged so that one bar of the rectangle could be slid over the others, in this way altering the self-induction in the circuit. Provision was also made for altering the capacity of this condenser by separating the plates to greater or lesser degree.

The discharge currents in the first rectangle induced currents in the other, but in general, the lecturer stated, these induced currents were too feeble to produce any visible effect, just as if two tuning-forks were taken at random and one struck, the other would, in general, not respond. If, however, the second fork were of exactly the same pitch as the first, it would itself give forth an audible note when the first was struck.

Lord Kelvin, the lecturer proceeded, had shown that the periodicity of a condenser circuit was proportional to $\sqrt{LC}$, where L denoted the self-induction of the circuit and C the capacity. The quantity L depended upon the length of the wire between the coatings, and, in the case of the resonator used by him, could be altered by sliding in one way or the other the movable bar of the rectangle. He showed that, on shifting this bar, a position could be found in which the neon tube in the circuit glowed brightly in response to the oscillations in the primary rectangle. The tuning of the circuit, he went on, could also be altered by separating to a greater extent the plates of the condenser. This diminished the capacity, and hence, to bring the resonator into tune again, it was necessary to increase the size of the rectangle by pulling out the sliding bar. Again, without altering the distance between the plates, the capacity could be changed by placing between them a sheet of ebonite, which increased the capacity; and to restore the balance it was then necessary, he showed, to diminish the self-induction. This latter experiment, he continued, was capable of giving very good results in the measurement of specific inductive capacities at very high frequencies.

To illustrate the very high frequency (often many hundred thousand oscillations per second) of the discharge-circuit of a Leyden jar, the lecturer showed that if two coils were placed side by side, and one coupled up with the electric-lighting circuit having a frequency of 100 per second, a lamp coupled to the other lit up under the currents then induced. Interposing a sheet of tinfoil between the two coils there was no perceptible diminution in the brightness of the lamp, though on the substitution of a stout plate of copper the effect on the brightness was very appreciable. The effect depended, he said, on the frequency of the alternations, and when these were slow a plate, to act as a screen, required to be of very considerable thickness and of very considerable conductivity.

Repeating a similar experiment with a primary coil inserted in the discharge-circuit of a jar, while a neon tube acted as an indicator for the secondary circuit, he showed that with the rapid vibrations then in operation the tinfoil acted as an effective screen. That the screening effect was not due to electrostatic action he showed by substituting for the tinfoil a sheet of wet paper, which proved to have no effect on the brightness of the indicating tube. The procedure illustrated in this experiment, he went on, could be used to measure the resistance of fluid electrolytes under alterations of several 100,000 per second. In this case the coils were arranged vertically one above the other, in a vessel filled with the liquid under examination, and by noting the distance between the coils necessary to extinguish the light the resistance of the liquid at these very high frequencies could be determined. With these high frequencies, he added, a good deal of conductivity was shown by substances not generally considered conductors at all—such, for instance, as highly rarefied gases.

To illustrate this, he showed an experiment in which a glass globe was surrounded by a coil forming the discharge circuit of a condenser. At the center of this glass globe was a second, smaller one, sealed and filled with hydrogen at a very low pressure. The outer globe was itself partially exhausted, and was provided with a stem containing charcoal, and this stem could be dipped into liquid air, thus causing the charcoal to absorb the gas and alter the pressure. At the outset the gas in the outer globe, being at a fairly high pressure, would not conduct. The charcoal on absorbing the gas rendered the residue conductive, and this was then capable of screening off the effect on the inner bulb, which required, he said, a very considerable conductivity.

On making the experiment, the lecturer showed that, at the outset, a ring of light circulated round and round the inner globe when the condenser was discharged through the outer coil. On then immersing the stem attached to the outer globe in liquid air the light diminished, and at one period of the experiment there was no light in either globe. As the pressure in the outer was, however, further diminished, a ring of light circulated round this outer globe, while the inner one remained quite dark.

The lecturer next proceeded to show that these high-frequency currents were confined to the surfaces of the conductors traversed by them, while a steady current flowed through the whole cross-section. High-frequency currents, on the other hand, extended only a small fraction of a millimeter (0.039 inch) into the skin of the conductor, which might accordingly as well be a tube as solid. The apparatus used consisted of two coils connected up in series with the Leyden jars, one of the coils having an exhausted bulb to act as an indicator, this bulb lighting up when the discharge passed. Putting a piece of brass into the first coil, no effect was produced on the brightness of the light in the bulb, while a similar block of iron caused an extinction of the light. The same effect followed on slipping a thin cover of iron over the brass and putting the latter back into the coil. This made it evident, Sir Joseph said, that the currents penetrated but a very short distance into the iron, and also that the latter still retained its magnetic properties when traversed by these high-frequency currents.

(To be continued.)

* Engineering.

RECENT PROGRESS IN AVIATION.—II.*

THE PRESENT STATE OF THE ART.

BY OCTAVE CHANUTE.

Continued from Supplement No. 1803, Page 68.

MEANWHILE we may go back to September, 1908, and note some of Orville Wright's performances. He had at Washington the same general arrangement, consisting of a launching rail, launching derrick, and an apparatus for hoisting up the weights in order to give the machine impetus. This aeroplane is 40 feet across and has a breadth of 6½ feet. The front rudder is 16 feet long, 2½ feet broad, and is equipped with skids, as shown in Fig. 7. The propeller is of peculiar and original construction and the motor is in every way the Wrights', for, in 1902, they made a canvass of the different makers of gasoline motors in this country, asking them to furnish a motor according to specifications which they presented. None of them at that time could do so and the Wrights went to work themselves, designed a motor, and built it with their own hands. This design has proven more reliable than the motors built in France, which are unduly light. The Wright motor, originally of 15 pounds to the horse-power, was reduced to 7 or 8 pound to the horse-power, while the French people are building motors weighing 4½ to 5 pounds, but they do not prove as reliable, while the Wright motor has never given any trouble and has proven reliable in every respect.

Orville Wright made a number of unofficial tests in 1908. On the 8th of September he rose to a height of 100 feet and flew 40 miles; on the 12th he made a little higher ascension, estimated by the army officers at 200 feet, and flew 50 miles in 1 hours and 15 minutes. Altogether that year he made 14 flights. On the morning of the 17th of September he made several short flights. In the afternoon of that same day he met with a terrible accident; his propeller broke while he and Lieutenant Selfridge were in mid-air, the machine falling to the earth, when Orville was seriously injured and Lieut. Selfridge was killed. This ended the tests of that year.

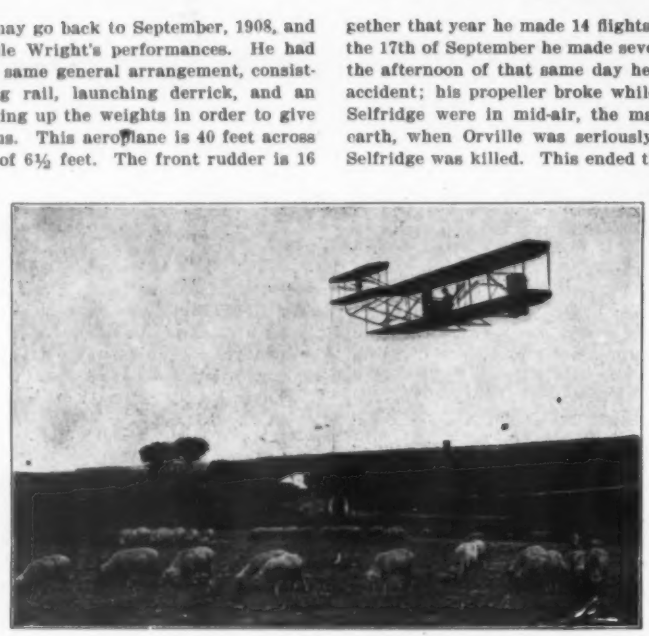


FIG. 10.—WILBUR WRIGHT AT ROME.

The government granted an extension of time and the trials were not resumed until July of this year (1909). The results this year, as you know, have been very successful. The official time test shows that on the 27th of July the machine remained in the air for 1 hour and 13 minutes, with two persons on board.

On the 30th of July the machine traveled 5 miles and back cross-country in 14 minutes, with two persons on board, at a speed which averaged over 42 miles an hour. Therefore, the machine was accepted by the government and a premium was given the Wrights of $5,000 for the extra two miles of speed. Wilbur Wright is now engaged in teaching the army officers how to use the machine.

Immediately after the acceptance of the machine, Orville Wright went to Berlin, and there he has been accomplishing some remarkable feats.

On the 29th of August last he made his first exhibition there, flying 15 minutes. On the 8th of September he went up with Captain Hildebrandt; on the 18th of September he went up with Captain Englehardt, and on the 17th of September he made a demonstration before the court. On the 2d of October he took up into the air the Crown Prince, who gave him a handsome present, and on the 4th of October he made a flight of 21 miles, reaching a height estimated at 1,600 feet. This is the latest performance which he has made, although there is no telling what another day will bring forth. He is now in Paris. In London he may make some demonstrations with his machine in the course of a week or two.

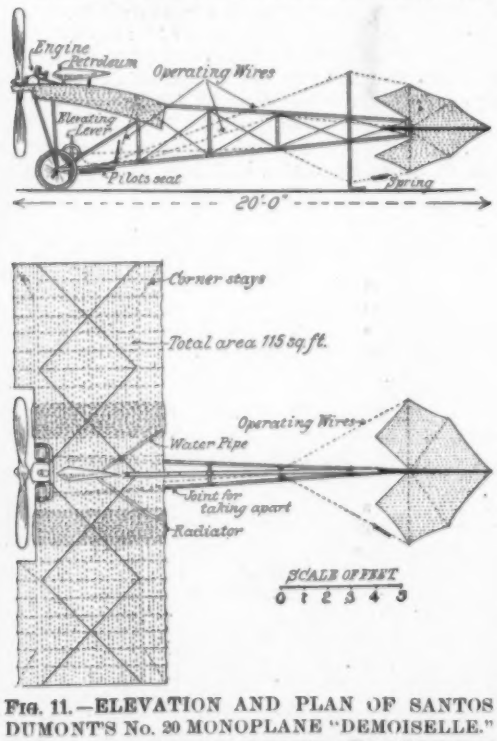


FIG. 11.—ELEVATION AND PLAN OF SANTOS DUMONT'S No. 20 MONOPLANE "DEMOISELLE."

Note the skid used at the rear instead of a wheel. The rudder-operating wires pass above and below the upright, the lower end of which is curved to form a skid. The lever and hand wheel in front of the seat work the horizontal and vertical planes of the tail respectively.

* Paper read before the Western Society of Engineers, and here reprinted from its journal.

The French, in 1905, became partly acquainted with what had been done in this country, and they thought it would never do to let the Americans obtain priority in the air, so a good many people began to experiment. Among the first was Santos Dumont, who made a flight on the 12th of November, 1906, of 720 feet in 21 seconds with his No. 14 machine, Hargrave type. That flight created great excitement, and the French people thought they were on the high road to beat the Americans, but it required a good deal of further experimenting before that result was even partially accomplished.

FIG. 12.—SANTOS DUMONT. ST. CYR TO BUC.

Santos Dumont brought the machine out a second time, but broke it. He then concluded that it was not built on the right plan and began to experiment with a modified machine. It proved unsatisfactory in various ways, and after it was broken he discarded it.

The next machine he tried was the biplane, the cellular partitions being removed. That ought, in my judgment, to have given satisfaction, but it did not and he abandoned it, although with that machine he made a flight, in Paris, on the 17th of November, 1907, of 500 feet.

He then went over to still another plan which he called the "Bird of Prey." In this design he placed the motor up in the top and had a dihedral angle in the biplane. But that did not give him satisfaction, and in the next machine he finally went over to the monoplane, which the French people have always insisted was the best design for a flying machine, and which they have promoted as against the biplane.

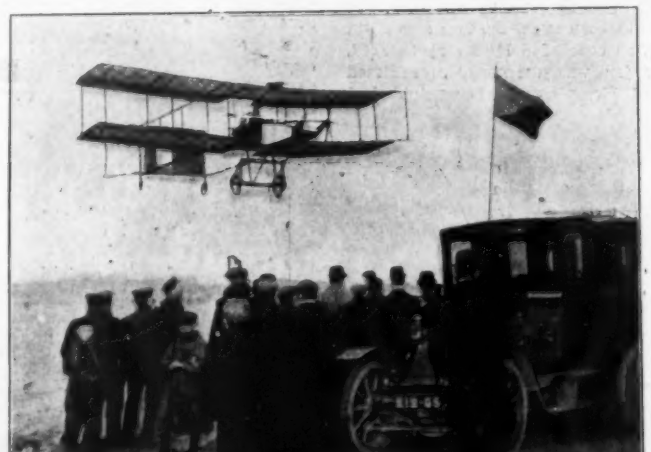


FIG. 13. DELAGRANGE ON THE VOISIN MACHINE.

Figure 11 is a view of the monoplane of Santos Dumont, and with that, on the 10th of March, 1909, he made a flight of 1,300 feet. On the 10th of April he made another flight of 1.2 miles. On the 19th of June he made a flight at Issy, near Paris, of 820 feet, at which time his machine was struck by a downward rush of air, and to his great astonishment he found himself suddenly on the ground. The machine had gone down without his knowing what was happening. Fortunately the machine was not broken and he was not injured.

Santos Dumont's idea had been all along to have a handy machine, and he finally built a baby monoplane, which he called the "Demoiselle" (Dragon Fly). This is the smallest of all the existing aeroplanes. Its supporting surface is only 97 square feet; its weight 260 pounds. When that is compared with the Wright machine, which has 500 square feet of supporting surface and a weight of 950 pound (the empty machine), we can appreciate the enormous difference and the necessity, therefore, of driving this Dragon Fly very much faster in order to obtain support from the air, with so very small a surface. On the 13th of September of this year, near Paris, Mr. Dumont was able to drive that machine five miles in five minutes, going down the wind, or at the rate of 60 miles an hour over the ground. The speed through the air was probably about 50 miles an hour. Fig. 12 is from a photograph taken during that flight, which was from St. Cyr to Buc. I think the general idea is sound, for the smaller the flying machine can be made, within limits, the faster it must be made to go, and the more useful it is likely to prove for varying wind conditions. Commercially I have no clear opinion as to its uses, but as a mode of rapid transportation for very light loads, I think the smaller the aerial plane the better.

As regards the question which has lately been debated extensively, of the relative merits of the biplane and monoplane, I do not think we are yet in position to decide which is the better design. Both have their good points. The monoplane offers less resistance, but the biplane is steadier, stiffer, and stronger in every way. So it is only experience that will determine which one is the more efficient.

Other experimenters have come into the field, and among the first was a clever young sculptor by the name of Leon Delagrange. He went to Voisin brothers and asked them to build him an aeroplane. This was called the Delagrange machine, but as a matter of fact the designing and construction was done by the Voisin brothers, who are a leading authority on the subject of building flying machines, and who, in two years, have had to enlarge their shop three times to keep up with their orders.

In Fig. 13 is shown the machine the Voisin brothers built for Delagrange. At first he did not trust himself to fly the machine, but got Voisin to ride in it and show him how. Subsequently he flew in it himself and all the later feats he has accomplished by himself.

On the 11th of April, 1908, he flew 2.5 miles at Issy; on the 27th of May, at Rome, 7.9 miles in 15 minutes and 26 seconds; at Milan, June 22d, 10.5 miles in 16 minutes and 30 seconds. Then he went to Turin and for the first time in history took a lady on board, who was very proud of the honor.

The picture, Fig. 14, is from the meet at Rheims in August, 1909, where Delagrange flew 31 miles on a monoplane. It may be remarked incidentally that there have been lately quite a number of these tournaments in Europe, which have attracted great crowds, have proved very satisfactory, and where all previous records have been smashed. One was at Rheims, where the Champagne people contributed large sums for the experiments. Another tournament took place later in Berlin, and still another in Juvisy, near Paris, in October, 1909.

The next man to gain prominence was the celebrated sportsman, Henry Farman, who walked into the Voisin shop one day and ordered an aeroplane. He succeeded, on the 26th of October, 1907, in flying 253 feet, which at that time was considered a great feat. He then attempted to sweep a circle, but did not succeed. It really took the French people two years to learn how to turn a corner. They were somewhat misled at first by a mathematical equation, and then closely analyzed the motions of the bird. They found that he flexed one wing at a lower angle than the other, placing himself thereby on a slant, so that the centripetal force of gravity should overcome the centrifugal force of the speed, and that similar effects could be produced by side fins and wing tips. Since that time they have turned corners without great difficulty but only on long radii.

Mr. Farman was successful, among other things, in sweeping curves on the 6th of July, 1908, when he flew 12 miles in 19 minutes and won the Armengaud prize which had been offered for the first turning of a corner. One of his flights is shown in Fig. 15.

On the 30th of October he made the first cross-country flight in history, by going from Chalons to Rheims, 17 miles in 20 minutes, thus winning great applause and becoming the foremost aviator in France. In 1909 he designed and built a flying machine of his own with which to compete at the Rheims tournament. He put both skids and wheels in this, the wheels being so adjusted that they could be lifted up, and with that apparatus splendid results were obtained in the Champagne tournament. The apparatus is shown in Fig. 16.

On the 18th of July that machine flew for 1 hour and 23 minutes at Chalons. On the 23d of July he took a cross-country trip covering 40 miles from Chalons to Suippe. On the 27th of August his machine made a flight of 112 miles at Rheims, which is the world's record for distance at present,[1] and he received, therefore, the first prize in that tournament. On the same day the machine flew 6 miles in 10 minutes with three persons on board, this being the first time three persons had ridden in a flying machine.

The next experimenter to be mentioned is Louis Blériot. He began his experiments in 1906, and has built and broken more machines than any other aviator in the world. He has built twelve machines and broken about fifteen, that being accomplished by rebuilding the same machine after smashing it. He is a man of tremendous pluck and wonderful imagination, and therefore tries all sorts of things. The machine with elliptical cells was launched on floats in the Seine in order to haul it up as a kite, and was Blériot's third. He had an idea that this elliptical arrangement would increase the stability very much, but it did not, and he gave up that idea. He then constructed No. 4, which he called a box-plane.

Machine No. 5 was of the Langley type, on the same plan that our army officers had been unable to obtain further funds to experiment with—two sets of wings, one behind the other—he placed it on wheels, and with that type he got some very fair flights, flying 474 feet. That was not enough for him, so he went from that to the monoplane and he has built, I think, six of them. Since then he has adhered to the so-called Dragon Fly plan and is now flying on No. 12. On the 13th of July, 1909, he flew 27 miles in 45 minutes. Fig. 17 shows the machine on which he made his journey cross-country from Etampes to Chevilly, a distance of 27 miles, and on that occasion he flew across a railway train, over one of the churches, and over various buildings.

On the 25th of July Blériot attempted to cross the British channel and succeeded. Fig. 18 is from a photograph taken on that occasion. That trip comprised a distance of 33 miles and was made in 37 minutes. It created great excitement, great applause, and great

[1] Since this talk, Mr. Farman made, on the 3d day of November, 1909, a flight officially estimated at 187¾ miles in 4 hours 6 minutes and 28 seconds, but really of 180 miles, over the aviation grounds at Mourmelon.

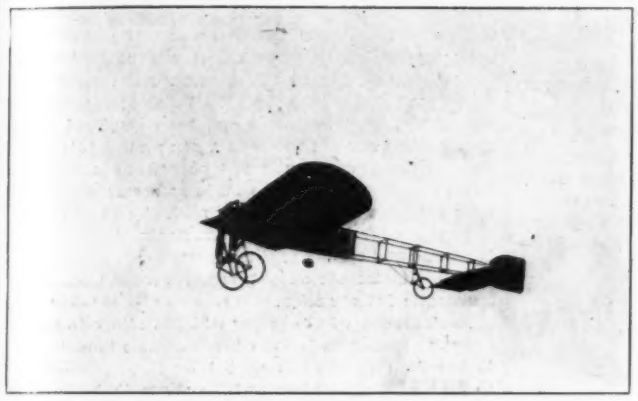


FIG. 14.—DELAGRANGE ON A MONOPLANE.

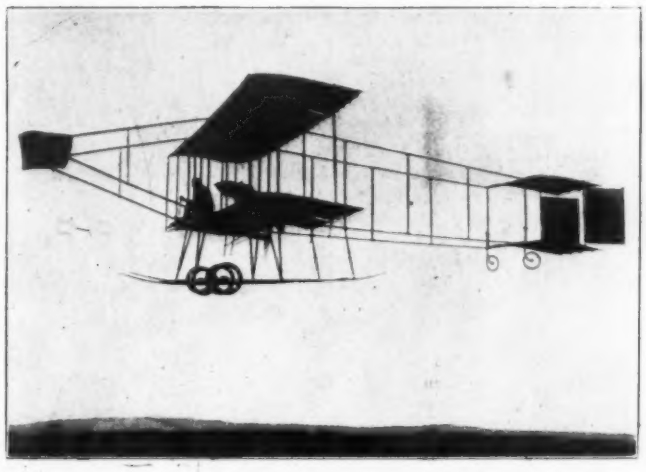


FIG. 16.—FARMAN'S BIPLANE.

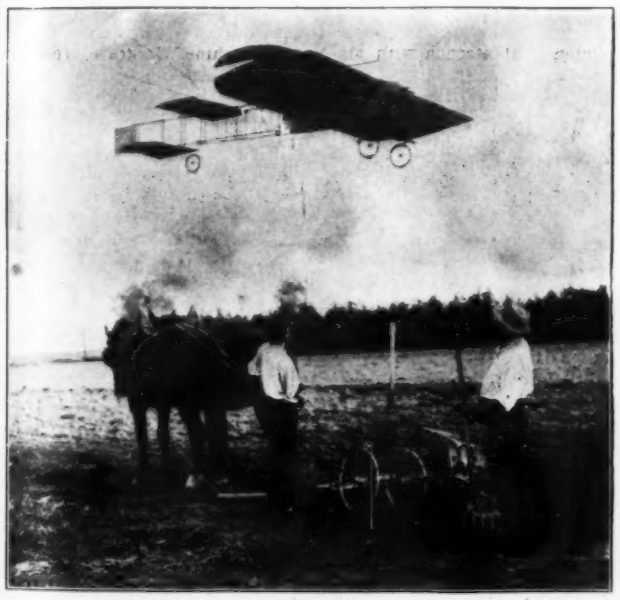


FIG. 17.—BLERIOT'S MONOPLANE. ACROSS COUNTRY.

FIG. 15.—HENRY FARMAN'S BIPLANE IN FLIGHT.

wonder, although, as a matter of fact, it was perhaps not as difficult a feat as the previous flying across country, but it appealed very much more to the imagination.

Blériot then went to the meeting at Rheims in Champagne, and there exhibited some very good performances. He flew over the grandstand at a very great height, made a trip on the 27th of August of 25 miles in 41 minutes, winning the ninth prize for distance, while on the succeeding day he flew 6 miles in 7 minutes and 48 seconds, winning the first prize for speed.[2]

(To be continued.)

LIGHT ALLOYS.

By WALTER ROSENHAIN.

THE problem of producing an alloy which shall combine great strength with a low specific weight has been before metallurgists ever since the commercial manufacture of aluminium became an accomplished fact; more recently, however, the requirements, in the first place, of racing yachts, then of motor cars and of motor cycles, and, finally, the pressing problems of aerial navigation, have added a rapidly increasing importance to the whole question. At the present moment German manufacturers particularly are putting forth claims in regard to achievements in this direction which appear startling at first sight, and it is interesting to examine the whole state of the question.

FIG. 18.—BLERIOT'S MONOPLANE FLYING ACROSS THE CHANNEL.

The need for a light alloy lies in the fact that pure or nearly pure aluminium is, unfortunately, very weak mechanically. Its low specific gravity (2.71) is more than counterbalanced by the fact that its tensile strength, even in the form of rolled bars, does not exceed 7 tons per square inch. If these figures are compared with those of the best special alloy steels suitable for structural purposes, we find that some of these show tenacities up to 64 tons per square inch, with a density of approximately 7.9. Consequently, a bar of aluminium, to bear the same ultimate load as a bar of such steel having a cross-sectional area of one inch, must have a sectional area of approximately 9 square inches, and would therefore weigh about three times as much as the steel bar. A light alloy which is to compete successfully with such special steels, therefore, must either be much lighter than pure aluminium or it must combine with the density of aluminium a tensile strength of 21 tons per square inch.

So far as alloys consisting principally of aluminium are concerned, it does not appear that this tensile strength has ever been attained, except in the case of hard-drawn wires the ductility of which has been reduced to an excessively low value. It must, however, be borne in mind that the high-tension steels referred to above cannot be employed in excessively thin sections, so that in many special cases, where the scantling of structural parts cannot be reduced to minute dimensions, while the strength required is not very great, light alloys may be employed with advantage as compared with alloy steel. The same argument applies, however, to a comparison made on similar lines between light alloys and the stronger kinds of wood. These woods are all considerably weaker, per square inch of sectional area, than the light alloys now available, but when their much lower density is taken into account, as well as the advantage of larger scantlings, the result must in many cases be favorable to the employment of wood. It is for this reason that the frames of most aeroplanes are constructed of wood. When, however, an alloy of density less than 3, and possessing a tensile strength of more than 20 tons per square inch under conditions allowing of a ductility equivalent to an extension of not less than 15 per cent on a 2-inch test-piece, becomes available, its employment will become advantageous as compared both with the best alloy steel and the best wood.

The light alloys available at the present time are somewhat numerous, and, as regards those of them which are patented or otherwise proprietary articles, it is difficult to obtain satisfactory data; it is certain, however, that extravagant claims are often advanced for such alloys, and these are not verified when samples are tried in a testing machine.

The claims of those advertising or selling such alloys must therefore be looked upon with much reserve.

Among the earlier alloys of aluminium which found a certain amount of practical application were those with iron and with nickel. One of the racing yachts engaged in one of the later races for the America Cup was built of plates rolled from one of these alloys, but the metal suffered from excessively rapid corrosion, and the presence of iron in aluminium alloys, although it undoubtedly confers considerable strength upon them, is rightly regarded as extremely undesirable. At the present time, the most completely studied of the light alloys are those in which copper is incorporated with the aluminium, either alone or with the addition of other elements, such as manganese. In the form of rolled bars and sheets, these alloys attain a tensile strength of slightly more than 17 tons per square inch, with an elongation of 15 per cent on 2 inches; these figures apply almost equally to alloys containing about 4 per cent of copper alone, or to those containing 3 per cent of copper and 1 per cent of manganese, or 2 per cent of copper and 2 per cent of manganese, the specific gravities of all these alloys lying close to 2.8. So far as trustworthy data are available, these figures probably represent the best available alloys of this character. Alloys of aluminium with from 15 to 20 per cent of zinc may possibly yield somewhat higher figures, but, owing to the presence of a considerable proportion of zinc, their density is also much higher, so that they can hardly be classed among the light alloys.

The light alloys at present employed in practice are principally used in the form of more or less complicated castings, such as motor-car engine crank-cases, the corresponding parts of aerial motors, and similar purposes. When thus used the alloys cannot be compared with special alloy steels, and still less with wood, and they hold the field quite easily against cast-irons, brass or bronze of any kind. For these purposes, hardness rather than ductility is desired, and alloys containing rather more than 4 per cent of copper, or the corresponding amount of manganese, can be employed. The casting of these alloys presents some difficulty, but a considerable number of founders are able to produce castings of this kind with regularity; the secret of their success lies largely in casting the alloy at a suitable temperature, and in the preparation of a mold having a hard and very dry surface. All the alloys of this class undergo a comparatively enormous amount of shrinkage in passing from the totally liquid to the totally solid condition, and unless due allowance is made for this contraction, faulty castings always result.

In the case of the aluminium-zinc alloys, a difficulty of another kind arises; while these alloys are less viscous when molten, and flow into the molds more freely than the aluminium-copper alloys, they are very weak and brittle while hot, and castings made of these alloys are very apt to crack while cooling if their contraction is opposed to any considerable extent; it is probably on this account that these alloys have acquired the reputation of being "treacherous." They have, on the other hand, been employed with some success for the production of so-called "die castings." These castings are produced by means of metallic molds, and can be made so accurate that no machining is required even for such objects as screw-threads and certain parts of instruments. On the other hand, these alloys are said to be weak under vibration, but this statement as yet requires confirmation by systematic investigation.

The question of the power of light alloys to resist corrosive influences is one of considerable importance; it has been generally accepted by those accustomed to deal with aluminium and its alloys that the pure metal is much more resistant to corrosion than any of its alloys, and, as regards some of these, this view is undoubtedly correct. The numerous "solders" which have been advocated for jointing aluminium and its alloys all suffer very seriously from this point of view. It must, of course, be borne in mind that aluminium itself has a powerful affinity for oxygen, and only protects itself from rapid atmospheric oxidation by the formation of a very thin coating of oxide on all exposed surfaces; if this coating is ruptured, as, for instance, by friction, continuous oxidation results, and the presence of an alloyed element in the form of a distinct constituent may cause such interruption. Again, the contact of aluminium with another metal, in the case of all those metals usually met with in engineering construction, leads to the formation of galvanic couples, and the consequent rapid corrosion of the aluminium. In this way also an alloyed element may intensify corrosion. On the other hand, it is equally possible that the presence of an alloyed metal may improve the protective coating of oxide formed on the surfaces of the metal, and there is good reason to believe that the presence of copper produces this effect to some extent, while the presence of manganese—as has recently been shown—facilitates the formation of a surface "patina" containing manganese oxide as well as alumina.

Even in the best circumstances, however, the protection of light alloys from corrosion is a most important matter, and this is accentuated by the difficulty of finding a suitable paint or varnish the constituents of which do not act upon aluminium—an action which generally takes the form of an interchange of oxygen between the pigment and the metal. Processes for coating the light alloys with a less corrodible metal, such as copper, tin, zinc, etc., have been tried, but these modes of protection are accompanied by the risk of an increased amount of local corrosion owing to galvanic action, if the metallic coating is anywhere broken through. A more hopeful line of thought is to be found in the development of processes for coating the alloys with an adherent layer of some inert compound of aluminium, much as iron and steel are coated with a layer of phosphate of iron in the "Coslettizing" process.

Finally, some reference may be made to the possibilities of the use of magnesium and its alloys for the production of light and strong materials of construction. The fact that magnesium has a specific gravity of only 1.74 at once suggests its use for such a purpose, but the fundamental objection lies in the fact that it is much more corrodible than aluminium, and that therefore the attainment of even moderate durability in its alloys must be a problem of much difficulty. That some solution of this problem may have been found is suggested by the statement recently made that the newest German Zeppelin airship is to

[2] Subsequently, December 13th, 1909, he was driven against a house during an exhibition flight at Constantinople, met with his twenty-second fall, and sustained injuries sufficiently severe, though not fatal, to require his going to a hospital.

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be constructed of an alloy known as "Elektron," said to be an alloy of aluminium and magnesium. Its density is stated as being close to 1.7, so that it must clearly consist of magnesium alloyed with only 1 or 2 per cent of aluminium. No data as to the strength of such an alloy are available, but from the known constitution of the alloys of the aluminium-magnesium system, it appears probable that the addition of aluminium to magnesium in proportions up to 7 or 8 per cent will materially increase the strength of pure magnesium, but the actual results cannot be predicted; it is, however, probable that pure magnesium is rather weaker than pure aluminium, so that it would be surprising to find in this group an alloy having a density less than 1.8, with a tensile strength above 10 or 12 tons per square inch. Alloys of aluminium with small proportions of magnesium are, it may be mentioned, in somewhat extensive use, particularly for certain parts of scientific instruments, under the name of "magnalium," but these alloys, although somewhat lighter, are not so strong as the best of the aluminium-copper and aluminium-copper-manganese series.

From the foregoing review of the question it will be seen that the problem of light alloys is still far from a satisfactory solution, and that there is a need for further systematic study of the alloys of the lighter metals.—Nature.

THE RASMUS ELECTRIC HOIST.

AN EXCEPTIONALLY LIGHT MACHINE.

An exceptionally compact and light electric hoist has been devised by Mr. Gustav Rasmus, of New York city. The apparatus owes its small dimensions primarily to the clever use of the hoist drum as the motor field frame.

In designing this hoist, it was the inventor's object to gain head room, to simplify the parts and reduce their number, and to make the hoist as small as possible without sacrificing strength, efficiency or durability.

As we have already stated, the end has been reached by making the drum of the hoist and the field of the motor in one piece, thereby reducing the weight. The metal which has strength enough to hoist the weight lifted by the hoist thus proves metal enough in cross section to act as a field for the motor. Hence, a standard type of motor is dismantled. The pole pieces are inserted in the drum of the hoist, and the brushes and armature are placed in position inside the drum be-

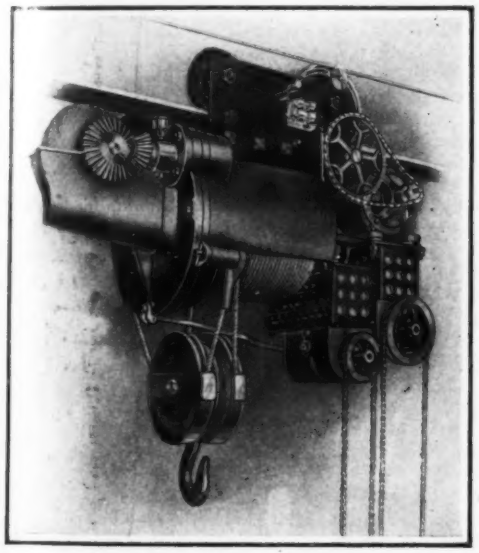

FIG. 1.—THE IMPROVED TYPE OF RASMUS ELECTRIC TRAVELING HOIST.

tween the two drum gears, which now actually constitute the front and rear casing of the motor.

By the reduction of these parts and by placing the armature within the drum, a number of castings and braces which are ordinarily necessary to hold the motor in alignment with the gears and the drum, are dispensed with. Thus much weight in iron and steel is saved, as well as the cost of material and labor.

In order to reduce friction to a minimum, the armature and the drum are designed to rotate in the same direction, the hubs of the drum gears being the bearings of the armature shaft.

By keying a worm to the extension of the armature shaft, the necessity of a load and speed brake is avoided; the motor is electrically controlled for speed, and when at a standstill, the gears are locked in position by the worm, thus preventing the load from sliding, whether the current is on or off. The armature extension is so arranged that the armature is allowed to have a forward or backward motion to the electrical center, and the worm is kept in position by thrust ball bearings.

The worm and the lower half of the worm wheel run in oil, so that they are constantly lubricated. The machine is so nearly completely inclosed that it is suitable for outdoor operation in any kind of weather.

The accompanying illustration shows the mounting of the controllers. Each is manipulated from the floor by pendant chains. The controller is a well-known standard make.

Various types of hoists are made on this principle, the largest having a 10 horse-power motor. The power of the traveling motor varies with the speed required. The hoisting speed of the five sizes may range from 30 feet per minute for the smallest to 12 feet per minute for the largest, and the weights from 675 to about 1,100 pounds.

The hoist is distinguished by the extremely large size of the shafts. Those in the hook block are 12 inches in diameter and the one on the back of the hoist, around which the rope takes its turn, is nearly as large. All sizes of the hoist require a head room of about 35 inches from the carrying part of the hook to the bottom of the rail. For smaller head room the hoist can be swung between I beams by casting lugs on the frame of the hoist for its support. The standard lift of the hoist is about 15 feet.

In the accompanying line engraving, a modification of the hoist, so that it may be used as an ash hoist, is shown.

The electric hoist of Mr. Rasmus may be converted into an ash elevator very simply. The brakes and outside shelf casting are left off, and the carriage or control entirely disregarded. Two brakes are bolted on to the side of this shelf or cover casting, and the brakes are secured either to channel irons or S-beams. The controlling apparatus is the same as on any other electric ash elevator which is cable-operated. There are limited stop bolts on the hand rope, and a centering spring on the controller should the rope become too slack or break. No brakes are necessary to hold the car, for the platform will remain in the position it is left when the current is cut off.

THERMAL MICROSCOPES.

By DR. KARL HEROLD.

THE idea of examining heated objects with the microscope is not a very new one. Chevalier (1804-1859) began by placing in front of the object glass of a horizontal microscope a metal plate, the ends of which were heated by spirit lamps, for the purpose of heating the object by conduction, but the attempt did not prove very successful. At a much later date Prof. Otto Lehmann repeated and varied these first modest experiments of Chevalier's, and ultimately devised a satisfactory method of heating microscopic objects, which made possible his exceedingly interesting discovery of liquid and apparently living crystals. The first description of Lehmann's thermal microscope was published in 1877. In the improved form in which the instrument is now constructed by Zeiss, the object is heated from beneath by a miniature gas burner, with a very delicate regulator, and is cooled from above by a diminutive bellows. By the combined action of these two devices any desired temperature, up to about 1,475 deg. F., can be obtained and maintained with remarkable precision. The names of Lehmann and Zeiss furnish a sufficient guarantee for the satisfactory performance of this instrument within the above-mentioned limit of temperature, but it is obvious that something very different is required for microscopic work at the high temperatures which must be employed in the study of certain problems in mineralogy and petrology.

For this purpose Prof. Doelter has devised a thermal microscope which, after undergoing various modifications, has assumed the form described below. The microscope proper differs from the microscopes which are ordinarily used in the examination of rocks only by the possibility of setting the objective at any distance from the stage, up to 6.4 inches, and of placing on the stage, as required, a larger or smaller tubular electric furnace. The largest furnace is 4 inches high and has an interior diameter of 2-5 inch. The furnace consists of a thin-walled tube of extremely refractory porcelain, which is encircled by a strip of platinum foil ⅛ inch wide and 1-600 inch thick, and is protected from loss of heat by radiation by a thick coating of asbestos. With this furnace observations can be made up to a temperature of 2,900 deg. F., at which nearly all metals and very many minerals fuse. As it is an easy matter to regulate the strength of the electric current with great precision by introducing resistance, any desired temperature can be maintained constant to within about 9 deg. F. for an indefinite time. The temperature is measured with a thermo-electric couple, composed of platinum and an alloy of platinum and rhodium, and connected with a very sensitive Déprez-D'Arsonval galvanometer, the scale reading of which gives the temperature directly in degrees Centigrade.

In order to protect the objective lenses from overheating, their mounting is surrounded by a jacket through which flows a continuous current of cold water. Overheating, however, would do little harm, as the flint and crown glass lenses of the achromatic combinations are not cemented together.

If only a moderately high temperature is required, the object may be laid on the top shelf of the smallest furnace, which is about 2 inches high. If, on the other hand, the fusing point of a very refractory mineral is to be determined—this was the problem that led Doelter to the construction of his thermal microscope—the mineral, in the form of coarse or fine powder, is placed in a dish made of fused quartz, which is suspended by three platinum wires in the center of the largest furnace, immediately above the junction of the thermo-electric couple.

In order to prevent loss of heat and also to protect the microscope objective above and the polarizing prism below from the intense radiation, the top and

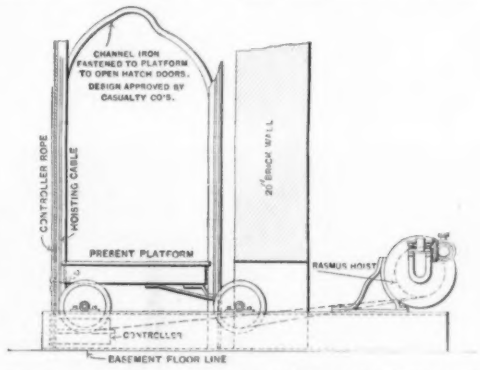

FIG. 2.—THE ELECTRIC HOIST ADAPTED TO ASH ELEVATOR SERVICE.

bottom of the furnace can be closed with plates of quartz glass.

At temperatures below 1,475 deg. F., at which point the furnace becomes self-luminous, and at higher temperatures, when the light of the furnace would interfere with the study of phenomena of polarization, the object is illuminated by a "Liliput" arc lamp.

Many minerals—the diamond, for example—burn when they are strongly heated in the air. For the study of such minerals at high temperatures a specially constructed furnace, through which a stream of inert gas can be forced, is provided.

The addition of a camera to the thermal microscope allows the observed phenomena to be photographed, and it is perfectly feasible to employ a kinematographic camera, such as Siedentopf and Sommerfeld use for the production of moving pictures of apparently living crystals.

The very high fusing points of a great many artificial combinations of silicates have been determined and the phenomena of crystallization on cooling have been closely studied with Doelter's thermal microscope in the mineralogical laboratory of the University of Vienna. In the study of crystallization it is especially important to be able to lower the temperature very slowly, and at any desired rate. With Doelter's apparatus this can be accomplished in a perfectly satisfactory manner.

A thermal microscope based on the same principles has been constructed by Dr. Day and Dr. Wright, of Washington. In the American instrument, however, the water-cooling apparatus surrounds the furnace, as well as the objective, and must seriously impair the efficiency of the former.—Umschau.

To Bleach Ivory.—Heat a mixture of unslaked lime, bran and water, lay the ivory in it (also with chloride of lime). Take the ivory out, put it into very dry sawdust, with which it must be thoroughly rubbed, then expose it to the air.

HEREDITY AND COLOR MARKINGS.

INHERITANCE OF ARTIFICIAL COLOR MODIFICATIONS.

BY DR. PAUL KAMMERER.

EVERYONE who has walked in the woods in rainy weather is familiar with the glossy black, yellow-spotted salamander, and everyone who has observed these little creatures closely must have been impressed by the fact that no two individuals are exactly alike in coloring. Nearly all the salamanders of some districts are very much spotted, those of other districts are hardly spotted at all, and in still other districts stripes take the place of spots. Even in the same locality great differences in pattern and in the relative proportions of the two colors are observed.

In the Wienerwald, in Lower Austria, only irregularly spotted salamanders are found. I collected a number of these salamanders which showed very numerous spots, or an unusually large proportion of yellow and placed them in a small glass house or terrarium, the floor of which was covered with black garden soil. Another lot of salamanders showing very few yellow spots, or a preponderence of the fundamental black color, which were also caught in the vicinity of Vienna, was placed in a second terrarium, on yellow loam. In both cases striking changes in the distribution of yellow and black were gradually produced by the change in environment.

Fig. 1 shows four stages, separated by intervals of two years, in the change in the markings of one of the much spotted salamanders which was transplanted to the black soil, and Fig. 2 shows the corresponding stages of an originally nearly black specimen transplanted to the yellow loam. Figs. 3 and 4 illustrate the effects produced by the same influences in young salamanders, the progeny of some of the animals collected in the wild state. The interval between the successive stages shown in Figs. 3 and 4 is only one year. By comparing the first and last illustrations of each series it will be seen that two years sufficed to produce, in the salamanders of the second generation, a change approximately equal to the change effected in their parents in six years.

The black soil in some way causes an increased production of the black pigment. The large, branched and sharply defined yellow spots, gradually become less bright, dwindle into small circles and dots, and finally disappear. The largest and most complex yellow markings subdivide and the fragments separate and pass away in the same manner (Fig. 1). The yellow loam, in a similar way, increases the production of the yellow pigment. The few yellow dots originally present increase in size and number and send out processes which produce a deeply indented contour. These extensions of neighboring spots exhibit a distinct tendency to grow toward each other and coalesce, so that the detached spots are ultimately replaced by a net-

FIG. 1.—EFFECT OF BLACK SOIL ON SALAMANDERS.

work of straight and curved yellow bands, the black interstices of which are variegated by newer and smaller yellow spots (Fig. 2).

I next endeavored to discover the causes and mechanism of these changes in pattern. The cause which first suggests itself is a direct physiological stimulation produced by the light reflected from the yellow and the dark soil, respectively, but as these soils differed chemically and otherwise, the possible effects of these differences must also be taken into account. I soon discovered that the yellow soil was more hygroscopic than the black, so that it remained moist in conditions which caused the black garden soil to crumble into dust. In order to separate the direct action of the reflected light from the other influences, I tried the effect of keeping the salamanders upon yellow and black paper. The yellow paper increased the yellow pigmentation, but only by enlarging the spots already present, without increasing their number. The black paper, similarly, merely diminished the size of the yellow spots, without affecting their brightness or sharpness of contour.

In order to isolate the action of moisture I placed salamanders in two vessels containing dry and wet sand. The latter had little effect in increasing the size and varying the shape of the spots already present,

FIG. 2.—EFFECT OF YELLOW SOIL ON SALAMANDERS.

but it produced numerous new round spots, which at first were indistinct. On the dry sand the existent spots lost little in extent, but they became less bright, as if a shadow had been thrown upon them.

All of these experiments were conducted both in ordinary daylight and in a dark room. In the latter, when the light was completely excluded, the direct effect of light was, of course, eliminated, but the above described action of moisture persisted. That is to say, in the dark room, the salamanders on yellow loam and those on wet sand gained in yellow pigmentation by increase in the number of spots only; the salamanders on black garden soil and those on dry sand lost yellow by darkening of the spots only; the salamanders on the yellow and black papers did not change at all.

From all this it appears that the increase in yellow pigmentation of salamanders living on yellow loam is due to the combined influences of light and moisture, the former increasing the size of the existing yellow spots and the latter producing new spots. The changes produced by black garden soil are due to a similar combination of the effects of darkness and dryness. Whether chemical and thermal influences also come into play (the black soil absorbs more heat than the yellow) must be left undecided for the present. Experiments bearing on this question are in progress but have not yet given any decisive result.

Although young salamanders were born in the course of several of these experiments, only those which were first born, of parents living on the yellow loam, are yet old enough to give distinct evidence of a regular inheritance of artificial color modifications. Newly-born salamander larvæ give no indication of their ultimate coloring, so that the degree of their resemblance to their parents cannot be decided until several months have elapsed. The female salamander shown in Fig. 2 was placed, shortly before parturition, in a glass vessel partly filled with gravel, the lower part of which was immersed in a shallow stratum of water. Here the young salamanders, 52 in number, were born, and here they passed their larval stage of development. After they had attained the adult form half of them (Fig. 3) were placed on yellow loam, and the remaining half (Fig. 4) on black garden soil.

The latter still show an unusually large proportion of yellow (although this is being gradually diminished by the influence of the black soil) and thus furnish indisputable evidence of the inheritance of an acquired character. The young salamanders which have been kept on yellow loam have already become almost entirely yellow, as under the influence of their environment they have acquired yellow pigmentation, in addition to that which their parents acquired, in like conditions, and transmitted to them. Another peculiarity exhibited by both sets of salamanders of the second generation, appears to possess especial significance. The markings, which were quite irregular in the parents, became perfectly regular in the offsrping.

The young salamanders which have been kept on black soil show several longitudinal rows of yellow spots on the sides and back, while in the young salamanders kept on yellow loam these rows of spots have become converted into broad yellow stripes.

In other words, the pattern, irregular in the parents, exhibits in the offspring the bilateral symmetry which is characteristic of vertebrate construction in general. —Umschau.

A NEW LUBRICANT.

By ENGINEER M. VORSTMANN.

FOR many years there has been unremitting effort to find a universal lubricant suitable for various needs in different kinds of machinery.

The application of the various lubricants, such as mineral oil, rape-seed oil, and grease, is governed by the special demands of different trades and conditioned by varying degrees of speed, temperature, and pressure.

Thus pins and pivots supporting a moderate weight at a low rate of speed use a suitably viscous oil, while in cases of high speed and pressure as, for examples, the crank-pins of large steam engines, rape would be used because of its fluidity.

The new lubricant, calypsol (Deutsche Calyspol-Transmission Weike, Düsseldorf), has proved itself possessed of an uncommonly wide applicability. It is a vegetable oil, manufactured in Canada. It is entirely acid-free, of very high melting point and correspondingly low freezing point, being thus obviously fit for machinery operated at high temperature, especially since its consistency is but very slightly altered at high temperatures.

It differs from the vegetable oils previously most used in not being subject to decomposition by the oxygen of the air. Consequently it does not form those free fatty acids which are so frequently injurious to the sliding surfaces and other parts of machinery. Furthermore, an acid-free fat does not become rancid, and forms no crust, even under long exposure to the air. It has a great advantage over mineral oil in not evaporating at high temperatures, while its ability to bear high pressure makes it suitable for use in stationary engines or motors carrying as high as 5,000 horse-power.

The new lubricating device employed with this oil has largely supplanted the ring apparatus previously thought indispensable for a high number of revolutions, and especially for electrical machines, and can be used for motors with as high a rate of speed as 3,000 revolutions per minute.

Fatty lubricants in general have the disadvantage of non-transparency, which permits solid bodies such as fragments of metal or stone to become imbedded

FIG. 3.

Effect of Yellow Soil on the Offspring of the Salamander Shown in Fig 2.

FIG. 4.

Effect of Black Soil on the Offspring of the Salamander Shown in Fig. 2.

and concealed in them to the subsequent detriment of bearings and shafts.

This new form of lubricant consists of calypsol grease kneaded into wool yarn.

Alloy for Fireworks Effect.—Zinc is melted with 5, 10, 15 or 20 per cent of magnesium (according to White). The alloy produced is cast in bars and reduced to filings, which may be mixed with an equal weight of thoroughly dried pulverized sugar 1 and chlorate of potash 1. To be ignited by contact with a red-hot body. The flame produced is the more blue, according to the predominance of the zinc, the whiter the more magnesium is present. Especially useful for signals to be visible at a great distance.

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THE TIN-MINING INDUSTRY OF CORNWALL.

MINING UNDER THE SEA.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

THE county of Cornwall is practically one huge mass of tin lode rock. The veins as a general rule run in a direction from north to south, and for the most part the granite is richly impregnated with the metal. Despite the rich nature of the veins, however, the industry has been severely crippled, unfortunately, by the existence of obsolete feudal laws, whereby heavy royalties and dues have to be paid to the land-owners upon both the percentage of metal raised and also for the rights to work the properties. Some idea of the exacting and heavy nature of these dues may be gathered from the fact that in the course of eighty-three years the Dolcoath mine, which is one of the oldest and richest properties in the county, expended $1,295,000 in this way, which was more than 25 per cent of the aggregate dividends paid to the shareholders during the same period. Moreover, the system of carrying out the extraction of the mineral is hopelessly antiquated, the same methods which prevailed before the discovery of tin deposits in other parts of the world for the most part still obtaining. During recent years many of the largest and most important mines have been overhauled as regards the working machinery, and although there is still room for considerable improvement in this connection, yet the state of affairs is much better than existed in the last decade of the past century.

Tin mining is one of the oldest industries in Great Britain. Since long before the Christian era the Phœnicians plied a thriving trade between Cornwall and the Mediterranean ports. Despite the fact that the metal has been exploited for over a score of centuries, there yet remain several million tons awaiting development. During the year 1905 fifteen mines produced 5,480 tons out of some 100,000 tons, which was the world's production for that year. Of this aggregate some 1,697 tons were procured from the Dolcoath mine alone, which is the largest and most famous in the county, the value of the output representing $3,674,000.

In the course of a century approximately six million tons of black tin have been obtained from this mine. On all sides of the pit mouth over a considerable acreage may be seen huge desolate mounds of dead slaty-colored rubble—the accumulation of centuries. The mine itself is the deepest in the county, the lowest working level being 3,600 feet, while the underground galleries extending in all directions and at varying levels aggregate over 80 miles in length. The mine is entered by the ancient mouth, the descent being by means of a cage. At the points where the veins of tin lode occur at different levels, cross drives branch off on all sides from the main shaft. The cross tunnels are for the most part driven north and south, which is the direction generally followed by the tin-bearing veins. The shaft of a tin mine is invariably divided into two sections by a wooden partition, one serving as the passage through which the ores are brought to the surface, while the other acts as the entrance and exit for the miners. The last before descent take a tallow candle, and by means of a lump of moist clay convert their hats into candlesticks. This is the only illuminating device with which he is equipped, and by reason of its primitive nature the light produced is both flickering and dim.

In the lower levels the heat is almost suffocating in its oppressiveness, and the miner must necessarily be of sturdy physique to withstand the rigors and labor of toiling in such temperatures, the heat rising in the proportion of one degree F. for every descending 53.5 feet. So intense is the heat in the lower levels that the miners for the most part can work only half-clad, and then only for half-hour stretches, their comrades meanwhile dashing cold water over them. At places the working faces are in large, spacious caverns, while in others the gallery is so narrow and low that the man has to toil in a cramped and difficult position. Where the strata of tin and copper lodes are richest, the rock with which they are impregnated is exceedingly hard, so that drilling becomes a tedious and laborious operation. In such places the chisel and hammer, which constitute the miner's principal equipment, make but little impression, and blasting has to be resorted to. A sum of about $90,000 is expended annually in explosives alone. The hole is bored with a rock drill, and a cordite cartridge with a safety time fuse inserted and tamped home. At the critical moment the miner shouts "Fire," at which signal all his companions in the vicinity, together with himself, retire to a safe distance. "Firing the hole," as it is called, disintegrates the rock. The shattered pieces are then loaded into little trolleys or skips, and hauled by ponies or pushed by the men themselves from gallery to gallery until the main shaft is reached. They are then hoisted to the surface. The tin miner is essentially a skilful worker. Often the cross cuts are driven by the simple guidance of the compass, and a shaft is frequently commenced at different depths, requiring cutting with such exactitude, that when completed, the sections coincide and form a continuous vertical excavation.

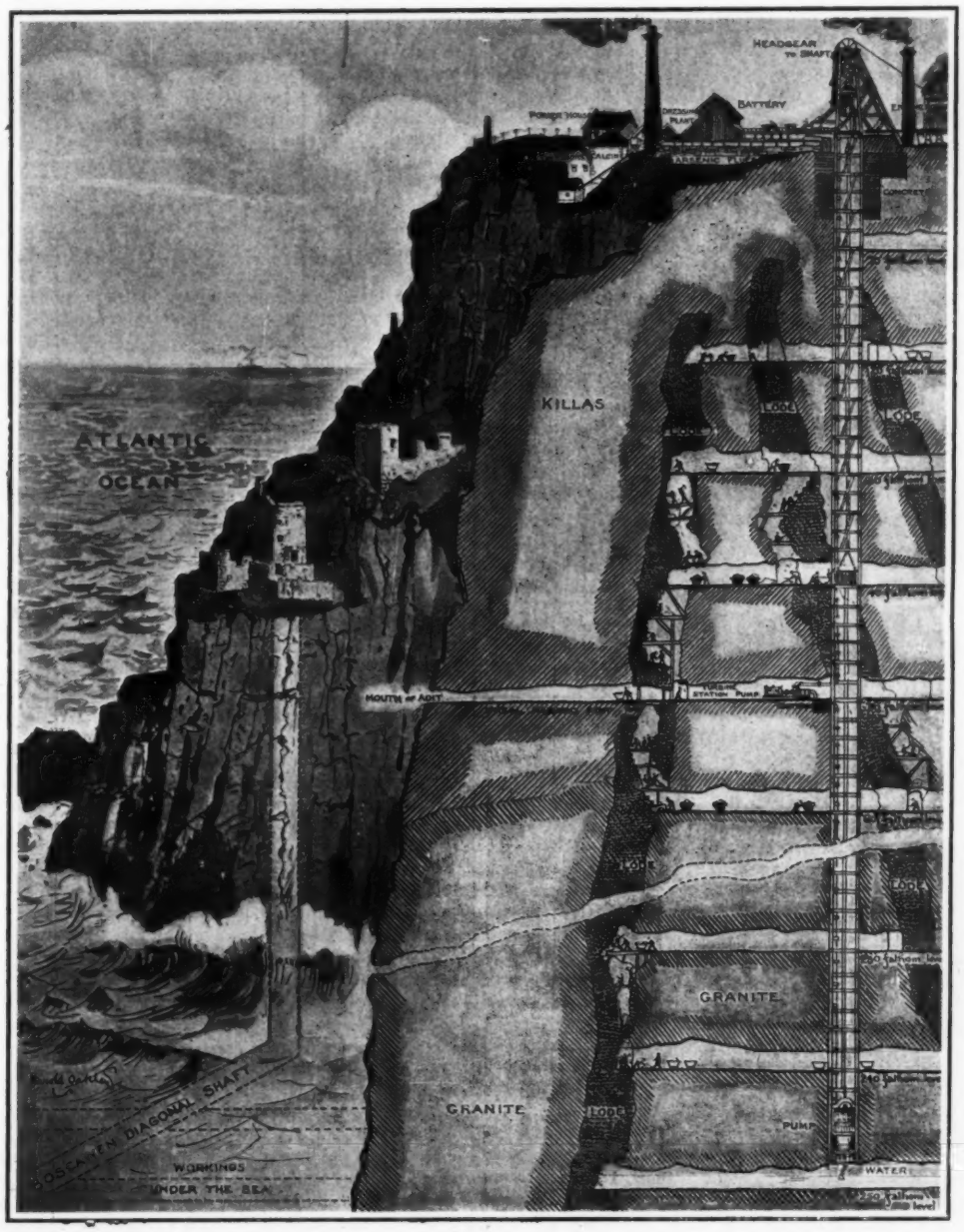

DIAGRAM OF BOTALLOCK TIN MINE ON MOST RUGGED PORTION OF CORNISH COAST.

It has immense workings, a large portion of which are under the sea. Dotted lines show Boscawen diagonal shaft. Method of working mine is by shafts as shown with drives at various levels. Ore is run from lode to shaft along a tramway and hoisted to the top. At head of shaft it is carried by hand-pushed tram cars to the battery; from there it passes through the dressing plant, then to the calciner, finally emerging as black tin on the tin floors, all of which are indicated in the drawing. The black tin is sold to the smelter.

Although the tin miner is spared the terrors of fire damp, which constantly confront the coal miner, yet he has a more terrible enemy in water. In the lower levels the men are engaged almost waist deep in water and slime heavily impregnated with arsenic, to the presence of which poison miners' phthisis is largely attributable, from which malady about seventy per cent of the Cornish miners ultimately succumb. An adit is usually driven up to the vein from a convenient valley, so that the level to which the water is to be pumped may be brought as low as possible. The pumping plant has to be kept in operation night and day without cessation, and the quantity of water discharged from a single mine occasionally amounts to as much as 1,600 gallons per minute, and as much as 37,000,000 tons of water have been discharged from sixty mines in the course of a year.

The miners work in eight-hour shifts, which spell includes intervals for meals, so that the actual working period is about six hours. That such a shift is sufficiently lengthy is plainly recognizable from the condition of the men, especially those working in the lowest levels, upon their emergence from the shafts. At the greatest depths, owing to the sultry atmosphere prevailing, the less stalwart miners often lose as much as five or six pounds in weight in perspiration during a single spell. From this it will be realized that an unusually good physique on the part of the men is required, in order to withstand the severe strain that is imposed upon the system.

Unfortunately, the depression in the tin industry has been attended by a corresponding depreciation in the available labor. The more expert miners have emigrated to the various colonies and American mines as the Cornish tin mines languished and ultimately closed down. The extent of this depression may be gathered from the fact that whereas fifty years ago there were 50,000 men engaged in the mines, in the year 1904 this aggregate had dwindled to 6,225, of which total only 3,500 men were underground workers. It is the scarcity of expert labor which is now handicapping the revival of the industry, and this problem promises to become more acute in the immediate future. Attempts to remedy the deficiency are being made by educating students as far as possible for the work, but such methods are not comparable with the hereditary experience which formerly prevailed, the

mining skill being then handed down from father to son through successive generations. Mining labor, so far as the underground work is concerned, is divided broadly into three classes, viz.: (1) "tut work," or contract labor; (2) "tribute," or payment by results; and (3) ordinary wage paid labor. To the experienced miner the former two classes are preferable, despite the element of speculation which enters into the schemes, since they call for skill, good judgment and energy upon his part. The ground may open out and the lode work more easily than anticipated; on the other hand, the reverse conditions might be encountered, the vein working hard and poor in yield, in which event the miner is distinctly the loser, but the system has the salient advantage that it produces a valuable class of laborers.

The ore upon its arrival at the pit's mouth is pulverized into small lumps either by the manual labor of girls or machinery preparatory for the steam or water driven stamps. The rock is here submitted to heavy pounding beneath ponderous rams or stamps, and crushed into fine powder of the consistency of flour. This process liberates the particles of tin from the quartz, but the metal is so heavily associated with other minerals, such as copper, sulphur, and iron, that it has to be subjected to a prolonged series of washings in order to extract the pure tin. The powdered quartz is passed over a number of washing tables by means of a steady stream of water. As the tin is the heaviest substance it quickly gravitates to the bottom of the pans, and collects in a sediment of black mud, which is subsequently dug out and packed into tubs, the product being known as "black tin" and sold under what is termed "wet weight." The cost of excavating, raising and treating the ore approximates about six dollars per ton, the average yield from a ton of ore being about 51.25 pounds—about 2.3 per cent. One ton of black tin yields about 70 per cent of white metal.

The tailings are treated on similar lines until almost the whole of the metal is recovered. Between the mines and the sea is a stream known as the "six miles." At frequent points throughout its course men known as "streamers" have installed buddles, frames, dipper wheels, pulverizers and settling pits for the recovery of that metal which has escaped the "vanning" process, as the sluicing over the moving tables is called. In this case the water tumbling over the rocky bed causes the tin to be released from the waste, and it is thus recovered. The output of the "streamers" alone is now worth approximately $300,000 per annum, and these men also find it profitable to work the old mine heaps, i. e., the huge masses of excavated ballast dumped around the mouths of the shafts. In former times, owing to the primitive methods adopted for recovering the tin from the ore, a large quantity of metal was unavoidably left behind. Now these waste heaps are being leveled and the contents pulverized, stamped and washed, and a fair yield is obtained. It is in this phase of the operations that some process similar to the cyanide method for dissolving gold in the tailings of gold mines is required for obtaining the tin from the tailings, since it is impossible to extract all the tin from the crushed ore by existent practices.

Accompanying the present revival in the industry, however, there has been a decided movement in reorganizing the machinery equipments of the mines, and a large amount of capital is being expended in this direction. By this means great economies in working are being effected, which with the older types of machinery were impracticable, while the yield per ton of ore is being rendered considerably higher. The magnetic separator is gradually coming into vogue, since there are many mines in which the ores are very poor, and which are otherwise scarcely profitable in working, that can be rendered more remunerative by the utilization of this process, the ores being peculiarly adapted for such treatment. The commercial possibilities of this system were first demonstrated in the magnetic separation of tin from wolfram at the San Finx mines in Spain, and its application in Cornwall though so far limited in extent has been equally successful.

The employment of this scientific process has also resulted in another distinct advantage. The tin ore as already mentioned is largely impregnated with other valuable minerals, such as copper, zinc blende, galena, tungsten, and arsenical and iron pyrites. Formerly only the tin (more essentially) and the copper were sought, the other minerals being ignored. The reason for this procedure, however, was that owing to their occurrence in a complex form they did not pay to work, and the smelter when offered these concentrates only paid for one of the contents, tin or copper as required, and regarded the presence of the other substances merely as impurities. Consequently, the concentrated ores were often sacrificed for less than they cost to raise. The extent of this ignorance is strikingly shown in the case of more than one mine, while the one at St. Ives is to be reopened. The refuse dumps around the mouth of the shaft are largely composed of uranium in the form of pitch blende. When the mine was worked in former days for its copper, this pitch blende was considered a nuisance. The miners at first carefully collected it and placed it on one side, under the impression that it was black copper ore. But when smelted the percentage of copper was found to be so small and inferior in quality that the miners and owners were disgusted. A sample was submitted to an analyst, who, ignorant in those days of the value of pitch blende, seriously informed the miners of its nature and prejudices, with the result that it was discarded as rubble. These refuse heaps have since been carefully investigated, and it has been discovered that the pitch blende is of excellent quality and exceptionally abundant. These discoveries have since resulted in the extraction of other minerals present in the discarded ore in addition to the desired tin, and although the quantities obtained are small, yet by the exercise of due economy in treatment their extraction can be rendered sufficiently profitable.

The means adopted for the disposal of the black tin by the miners is decidedly curious. The miners, who have defrayed the whole expense of raising and dressing the tin, receive as their reward a percentage upon the amount realized at auction. These sales take place weekly, and each miner displays the quantity of his product in heaps up to one hundred tons in bulk. Each purchasing agent examines the samples, and indicates upon a piece of paper the price he is prepared to offer per ton. These slips of paper are handed to the auctioneer, who then selects the highest bidder, who thus becomes the purchaser. In this manner several thousand tons of black tin are disposed of without a single word being uttered. The percentage yield to the miner as a result of his work varies from 3 to 60 per cent on the dollar, according to the richness or poverty of the ore obtained. The principle of working "payment by results" saves the owner a considerable amount of detailed survey in mining, while at the same time it stimulates the miner to raise as much ore as possible. Should the miner, however, be so unfortunate as to strike a bad pitch and regret his bargain, he can retract from his undertaking by the payment of five dollars and select a new claim.

While the Dolcoath is the most famous and important of the Cornish tin mines, and furthermore has the deepest workings, the Tincroft and Levant mines are also notable. In the latter case the galleries are driven out in the bed of the Atlantic, the most distant point of the subterranean working from which the ore is extracted being about one mile from the shore in the sea-bed. The ores there obtained are exceptionally good, being rich not only in tin, but in copper and arsenic as well. With this mine, however, the greatest difficulty is encountered in connection with water, the galleries being only a little below the surface of the ocean bed.

WHAT IS PRAGMATISM?

By THOMAS MITCHELL SHACKLEFORD.

TO BEGIN with, not only has no history of the origin, rise and spread of pragmatism yet been written, but no full, complete, systematic statement of what it really is, what it does and what it may be expected to do is to be found anywhere.

However, for all practical purposes, it still remains as true as in 1905, when Prof. James wrote concerning the movement:

"It suffers badly at present from incomplete definition. Its most systematic advocates, Schiller and Dewey, have published fragmentary programs only."

Definitions must necessarily delimit and restrict, consequently with the growth of knowledge they become insufficient and obsolete. The discovery of one new fact may invalidate and completely overthrow a definition that may have passed current and remained unchallenged for years. In other words, "new facts burst old rules" and definitions, both are man-made products, so it should never be forgotten that definitions and "rules are made for man, not man for rules" and definitions. No science is finished, none can be called exact, all are in the process of formation. To illustrate. Who can define matter, or ether, or electricity? Of how much value now are many of the definitions in physics or chemistry of ten, or even five, years ago? All definitions, then, at least, along scientific lines or in any living, growing branch of study, should be regarded as provisional only, true only up to date, and, like railroad schedules, subject to change without notice to the public.

Before the movement was fairly launched, or an opportunity had been afforded its leaders of getting together and comparing notes as to their common message and unifying it, if possible, the critics had attacked it on all sides and from every quarter. This caused a rush of both friends and foes, professionals and tenderfeet, to this newly discovered philosophical Klondike, which has been productive of much confusion and misunderstanding. Reconciling these conflicting statements is simply out of the question, and I shall not attempt the impossible.

Disclaiming right at the outset all intention of speaking as one clothed with authority, fully realizing that what I may say is binding upon no one, my mission is simply to set forth what pragmatism is, as I undertand it. Even this I venture upon with diffidence. As an excuse for my seeming rashness, if such be needed, I would repeat what the protagonist of pragmatism himself has said:

"Whoever will contribute any touch of sharpness will help us to make sure of what's what and who is who. Any one can contribute such a definition, and, without it, no one knows exactly where he stands."

My purpose, however, is not to add another to the many existing definitions, but rather to weigh and compare some of those already current. In other words, I merely propose to examine the history of the movement with the intention of ascertaining, if possible, what pragmatism is.

It is easy enough to tell of the origin of the word and that it is "derived from the same Greek word πράγμα, meaning action, from which our words 'practise' and 'practical' come." Now this not only does not tell us much, but has actually proved misleading and is responsible for some of the current misunderstandings. But it is too late now to rectify this most unfortunate selection of a name.

The first person to use the word pragmatism in print was Prof. James, in his California address in 1898, wherein he sets forth the principle as follows, with the prefatory statement that "it may be expressed in a variety of ways, all of them very simple: The soul and meaning of thought can never be made to direct itself toward anything but the production of belief, belief being the demicadence which closes a musical phrase in the symphony of our intellectual life. Thought in movement has thus for its only possible motive the attainment of thought at rest. But when our thought about an object has found its rest in belief, then our action on the subject can firmly and safely begin. Beliefs, in short, are really rules for action; and the whole function in thinking is but one step in the production of habits of action. If there were any part of a thought that made no difference in the thought's practical consequences, then that part would be no proper element of the thought's significance. Thus the same thought may be clad in different words; but if the different words suggest no different conduct, they are mere outer accretions, and have part in the thought's meaning. If, however, they determine conduct differently, they are essential elements of the significance, 'Please open the door,' and *'veuillez ouvrir la porte,'* in French, mean just the same thing; but 'D—n you, open the door,' although in English, means something very different. Thus to develop a thought's meaning we need only determine what conduct it is fitted to produce; that conduct is for us its sole significance. And the tangible fact at the root of all our thought-distinctions, however subtle, is that there is no one of them so fine as to consist in anything but a possible difference of practise. To attain perfect clearness in our thoughts of an object, then, we need only consider what effects of a conceivably practical kind the object may involve—what sensations we are to expect from it, and what reactions we must prepare. Our conception of these effects, then, is for us the whole of our conception of the object, so far as that conception has positive significance at all."

He goes on to say:

"This is the principle of Peirce, the principle of pragmatism. I think myself that it should be expressed more broadly than Mr. Peirce expresses it. The ultimate test for us of what a truth means is indeed the conduct it dictates or inspires. But it inspires that conduct because it first foretells some particular turn to our experience which shall call for just that conduct from us. And I should prefer for our purposes this evening to express Peirce's principle by saying that the effective meaning of any philosophic proposition can always be brought down to some particular consequence, in our future practical experience, whether active or passive; the point lying rather in the fact that the experience must be particular, than in the fact that it must be active."

All this seems to be perfectly plain and simple, but, in view of the misunderstandings that are still current concerning the principle, due largely to flagrant, if not wilful misrepresentations, and as this is the beginning point of the "new philosophy," I trust that you will pardon still further extracts. The gifted lecturer tells us that "to take in the importance of this principle, one must get accustomed to applying it to concrete cases," and the entire address is devoted to such applications along religious and philosophical lines. He says:

"This is one of its first consequences. Suppose there are two different philosophical definitions, or

propositions, or maxims, or what not, which seem to contradict each other, and about which men dispute. If, by supposing the truth of the one, you can see no conceivable practical consequences to anybody at any time or place, which is different from what you would foresee if you supposed the truth of the other, why then the difference between the two propositions is no difference—it is only a specious and verbal difference, unworthy of further contention. Both formulæ mean radically the same thing, although they may say it in such different words. It is astonishing to see how many philosophical disputes collapse into insignificance the moment you subject them to this simple test. There can be no difference which doesn't make a difference—no difference in abstract truth which does not express itself in a difference of concrete fact, and of conduct consequent upon the fact, imposed on somebody, somehow, somewhere, and somewhen."

After stating that "it is the English-speaking philosophers who first introduced the custom of interpreting the meaning of conceptions by asking what difference they make for life," he adds:

"Mr. Peirce has only expressed in the form of an explicit maxim what their sense for reality led them all instinctively to do. The great English way of investigating a conception is to ask yourself right off, What is it known as? In what facts does it result? What is its cash-value, in terms of particular experience? And what special difference would come into the world according as it were true or false?"

"For what seriousness can possibly remain in debating philosophic propositions that will never make an appreciable difference to us in action? And what matters it, when all propositions are practically meaningless, which of them be called true or false?"

If pressed in these different ways but all meaning the same thing, it would seem that Dr. Schiller was right in saying that the principle "ought to be regarded as the greatest truism, if it had not pleased intellectualists to take it as the greatest paradox."

After all that has been written on the subject, a writer has quite recently said:

"Ninety-five per cent, and a little more, of all who have rallied so valiantly to the pragmatic banner totally misunderstood the new philosophy. And it is even near the truth to say that 100 per cent of all the critics who to their own satisfaction have completely demolished the pragmatic structure have fired their shots at the wrong target."

Even if this contains only a half-truth, it behooves us to try to get our bearings, although philosophical orientation be fraught with all the difficulties that have been claimed. In any event, it is of the utmost importance to get the right point of beginning, so I have thought it advisable to set forth Prof. James' exact words when he first announced the principle.

So far as I have been able to discover, the next time he announced it was in his "Varieties of Religious Experience," where he condensed it. I quote only one sentence:

"To attain perfect clearness in our thoughts of an object, we need then only consider what sensations, immediate or remote, we are conceivably to expect from it, and what conduct we must prepare in case the object should be true."

I should like you to note especially the added words, "immediate or remote." I would also call attention to the fact that none but a pragmatist could have written this truly delightful book. The eighteenth chapter, bearing the title "Philosophy," is simply a clearly wrought-out application of the principle in the philosophy of religion.

In Baldwin's "Dictionary of Philosophy," Prof. James defines the principle as follows:

"The doctrine that the whole 'meaning' of a conception expresses itself in practical consequences, consequences either in the shape of conduct to be recommended, or in that of experience to be expected, if the conception be true; which consequences would be different if it were untrue, and must be different from the consequences by which the meaning of other conceptions is in turn expressed. If a second conception should not appear to have other consequences, then it must really be only the first conception under a different name. In methodology it is certain that to trace and compare their respective consequences is an admirable way of establishing the different meanings of different definitions."

In an article entitled "Humanism and Truth," published in Mind for October, 1904, he says:

"First, as to the word 'pragmatism.' I myself have only used the term to indicate a method of carrying on an abstract discussion. The serious meaning of a concept, says Mr. Peirce, lies in the concrete difference to some one which its being true will make. Strive to bring all debated conceptions to that 'pragmatic' test, and you will escape vain wrangling; if it can make no practical difference which of two statements be true, then they are really one statement in two verbal forms; if it can make no practical difference whether a statement be true or false, then the statement has no real meaning. In neither case is there anything fit to quarrel about; we may save our breath, and pass to more important things.

"All that the pragmatic method implies, then, is that truths should have practical consequences. In England the word has been used more broadly to cover the notion that the truth of any statement consists in the consequences, and particularly in their being good consequences. Here we get beyond affairs of method altogether; and since my pragmatism and this wider pragmatism are so different, and both are important enough to have different names, I think that Mr. Schiller's proposal to call the wider pragmatism by the name of 'Humanism' is excellent and ought to be adopted. The narrower pragmatism may still be spoken of as the 'pragmatic method.'"

Pragmatism, being what its protagonist says it is, ought not to be expected to mean the same thing or to make a like appeal to different minds. Evidently, it was with deep design that Prof. James began the first lecture in his "Pragmatism" with that paradoxical quotation from Mr. Chesterton's "Heritics," as to the most important thing about a man being his philosophy. It contains a greater modicum of truth than most paradoxes, for as a man's philosophy is, so will be "his view of the universe," and, as that view is, so will be his life. From this paradox our pragmatist proceeds to develop the thesis that "the history of philosophy is to a great extent that of a certain clash of human temperaments," and to show us how temperament "loads the evidence" not only for philosophers, but for all of us. In this he follows Fichte, who has said somewhere, "what system of philosophy you hold depends wholly upon what manner of man you are." So Dr. Schiller has said, "the fit of a man's philosophy is (and ought to be) as individual as the fit of his clothes." All this must naturally follow if we agree with Mr. R. R. Marett, who has said:

"There is at least a half-truth at the back of the view that a man is born either a Platonist or an Aristotelian, a Stoic or an Epicurean, an intuitionist or a utilitarian, an idealist or a materialist. We are spiritually-minded or worldly-minded, believers or skeptics, romanticists or realists, and so forth, primarily at least in virtue of a certain fundamental endowment of massive sentiment."

Our "great student of the human soul" has said, this particular difference in temperament "has counted in literature, art, government and manners as well as in philosophy." He should have added religion, for in no other department of life has temperament played a more important rôle, as he himself has superbly exemplified in his "Varieties." This furnishes the key to the explanation of why "God has two families of children on this earth, the once-born and the twice-born," to use Francis W. Newman's significant phrase. There is no escaping it. By shaping our faith for us it largely "divides us into possibility men and anti-possibility men" and explains why "each of us dichotomizes the Kosmos in a different place," thereby each making for himself the world in which he lives. We have certain rules by which we can calculate with approximate correctness the variation of the magnetic needle from the true North and South line, but, most unfortunately, we have no rule for computing temperamental variation.

Pragmatism, therefore, being primarily a method of thought, "an attitude of orientation," neither designates nor leads to any "specific philosophic creed"; and is not a system or a metaphysic. Dr. Schiller has cogently said that it is "an epistemological method which really describes the facts of actual knowing." That it should somewhat definitely point to a metaphysic and also prove to be "a genetic theory of what is meant by truth" should prove no surprise to us, but, as important as all this is, it must be considered as secondary. One of its chief beauties and attractions is that it leaves each one of us perfectly free to develop his own particular "ideals and over-beliefs, the most interesting and valuable things about a man." Thus it has led Prof. James to "radical empiricism," Mr. Peirce to "pragmaticism," Prof. Dewey to "instrumentalism" or "immediate empiricism," Dr. Schiller to "humanism," and others to "the thirteen pragmatisms," of which we have been hearing so much of late. All this is as it should be and is greatly to its credit. But these different terms should not be confounded with each other, used interchangeably as though they were synonymous, or identified with pragmatism, as has been done by some friends and many foes of the movement. At all hazards, the pragmatic method must not be permitted to become identified with any one of them. That would be only the first step toward its crystallization into a creed or petrifaction into a dogma. That would be but to follow blindly in the footsteps of those teachers who have so treated the Christian religion, thereby creating schisms, sectarianism, and that intolerant party spirit "which blights and cankers the truth itself." Whatever Christianity may be now, primarily it was a method of living, a principle of life—not a creed or dogma.

For us, in this day and time, to repeat this blunder would simply be indefensible and unpardonable. However desirable unity may be, it should never be purchased at the expense of truth and freedom. Dr. Schiller says:

"Two men, therefore, with different temperaments, ought not to arrive at the same metaphysic, nor can they do so honestly; each should react individually on the food for thought which his personal life affords, and the resulting differences ought not to be set aside as void of ultimate significance. . . . No two men ever think (and still less feel) alike, even when they profess allegiance to the self-same formulæ."

Consequently, the pragmatic method will not prevent the formation of different systems of philosophy, which may be expected to "abound as before, and be as various as ever." They will still "have their day and cease to be," in the future as in the past, being necessarily only "broken lights," but pragmatism will not fall with them, for the reason that it will be "more than they" and, therefore, not identified with any of them.

That pragmatism should have encountered bitter opposition was what might have been expected. Has it not been so with every great movement in human thought from the time of Protagoras, with his famous dictum, "man is the measure of all things," down to the present time? It seems inevitable that all must run the gauntlet of criticism. Perhaps, this helps to determine "the survival of the fittest." Prof. James R. Angell has recently said:

"Signs are not wanting that the asperity of its critics is already softening—especially those who come out from behind the screen of anonymous reviews."

This would seem to be true, since even Mr. Bradley has said of Prof. James's last book:

"While reading the lectures on Pragmatism, I, doubtless like others, am led to ask myself, 'Am I and have I been always myself a Pragmatist?' This question I still find myself unable to answer."

However, the distinguished author of "Appearance and Reality" may have made this statement in a Pickwickian sense. If it be true, as has been somewhat sneeringly said, that pragmatism has made comparatively few converts among the professional philosophers, but has made its strongest appeal to the men in the street, it may be fittingly replied that this has been likewise true of the greatest movements in the world's history. That the common people have heard its teachers gladly may prove to be, not its reproach, but its honor and glory. Again and again it has happened that "not many wise men after the flesh, not many mighty, not many noble, are called," but rather those who have become as little children, single-minded and simple-hearted.—Abstracted from Popular Science Monthly.

PRODUCTION OF COLLOIDAL SOLUTIONS BY MEANS OF ULTRA-VIOLET RAYS.

In 1889, Messrs. Lenard and Wolf discovered the fact that metals become pulverized when subjected to ultra-violet light. This phenomenon has just been utilized for the first time by Th. Svendberg, of Upsala, for producing colloidal solutions of various metals in various liquids.

The metal to be pulverized is cleaned on its surface from any oxid layer adhering thereto. It is then placed in a shallow dish containing the solvent and is exposed from above to radiations from a mercury lamp (in a quartz bulb) held a few centimeters away. After a few minutes, the liquid, viewed under the ultra-microscope, has taken the characteristic appearance of a colloidal solution. Different metals and solvents present phenomena of great variety. Thus silver, copper, tin and lead are pulverized very rapidly in the formation of colloidal solutions, while platinum, aluminium and cadmium exhibit little or no pulverization.

As regards lead and silver, Svendberg extended his experiments not only to water, but to many other solvents, with widely different results with respect to the size and number of particles. The preparation of solutions containing particles of great uniformity and minuteness, and having very active Brown motions, is particularly worthy of attention.

It is evident that further researches will be required to elucidate the rationale of this group of phenomena. These investigations, now being pursued by the experimenter, will show above all the influence which should be attributed to the electric charges of the material to be pulverized; incidentally, these investigations may throw some light on the course of photographic reactions.—Umschau.

EDISON ELECTRIC CO.

ENGINEERING NOTES.

According to F. Raschig, a mixture of coal tar with a small proportion of clay readily emulsifies with water, and is very suitable for the treatment of road surfaces. After drying, the tar becomes insoluble, and is then not affected by rain. The mixture of tar and clay, named "Kiton," is also very useful as a tar paint since it can be applied to cold and wet surfaces of all kinds, and after drying, forms a water-resistant coating.

In an American patent taken out by S. Forgo, a new process and apparatus for making glassware is described. Molten glass is made to flow between directing or molding surfaces, and a film of cool gas is interposed between these surfaces and the material, the glass being gradually reduced in thickness as it proceeds. The apparatus consists of a vessel which is divided into an inlet compartment, in which a pressure may be maintained, and an outlet compartment; two directing members, forming a gradually contracting chamber, extend from the latter, and the gaseous film is produced on the inner surfaces of these members by making them, for instance, of porous material and constituting the inner walls of two chambers containing a vaporizable liquid.

That vibrations in buildings may sometimes cause serious damage is pointed out by B. Galitzine in the Comptes Rendus. He found that in two houses in St. Petersburg, close to a Diesel engine with four cylinders, of 200 horse-power total, serious cracks formed in the walls sufficient to interfere with safety. He studied the subject and found that, where there are high-speed motors installed, which are not well balanced as to weights, vibrations are set up which cause continual movements in neighboring buildings of a kind that often results in menacing the solidity of the building. The ordinary seismograph is of little use in investigating these movements, and Mr. Galitzine gives a diagram illustrating an apparatus by means of which the absolute value of either vertical or horizontal vibrations may be measured. The various equations for the apparatus are given; the principle of the instrument being that of observing the movements of a flat steel spring upon which there is a sliding weight.

Before the Faraday Society, Mr. J. W. Hinchley recently gave the results of some practical experiments of the sherardizing process for the successful coating of iron or steel articles. The most impotant factor is the content of metallic zinc in the zinc dust used; the limits of time and temperature are comparatively wide. The best results are obtained with zinc dust containing 18 per cent of metallic zinc. Hinchley considers that Cowper-Coles' view that zinc is vaporized from the zinc dust and condensed on the iron or steel articles is not correct, for no deposit can be obtained from zinc vapor at temperatures below the melting point of zinc, such as are used in sherardizing. In the latter process the deposition begins at a temperature just above that required to produce a film of magnetic oxide on the iron, and the deposit invariably contains iron. It is concluded that the coating is a closely adherent film of a solid solution of iron in zinc produced by the interaction of the metallic zinc in the zinc dust and the film of magnetic oxide of iron. If the proportion of metallic zinc present be low, a black film of reduced iron is formed. The zinc coating is very resistant to atmospheric corrosion, after the slight yellowish powder which is first formed, has been washed off: sherardized chain blocks have remained free from rust after use for seven years in the open air.

SCIENCE NOTES.

D. Berthelot and H. Gaudechon have shown that exposure to ultra-violet rays from a quartz mercury vapor lamp produced no appreciable effect on air or on mixtures of nitrogen and oxygen. Nitrous oxide, alone or mixed with oxygen, and nitric oxide, were decomposed, with formation of free nitrogen and nitrous and nitric acids. Sulphur dioxide, alone or mixed with oxygen, yielded free sulphur and sulphuric acid.

Prof. Edward W. Berry of the Johns Hopkins University of Baltimore is the author of "A Revision of the Fossil Plants of the Genus Nageiopsis of Fontaine," which is issued as paper No. 1738 of the Proceedings of the U. S. National Museum. In connection with his studies of the Potomac flora of Maryland for the Maryland Geological Survey, Prof. Berry found it necessary to re-examine all of the Virginia material, and in many cases to recast certain of the larger genera where the limits have been found to be vague. Many of these reviews affect species of fossil plants known to occur in Maryland, and therefore their publication became desirable. The types of these species are in the collections of the U. S. National Museum.

The Japanese, who do not like to be the last in any movement, are beginning to take interest in Polar exploration. The announcement has been made that in August, 1910, Lieutenant Shirape will start from Japan with a schooner of 150 tons and 15 Manchurian ponies for the conquest of the South Pole. It will be seen that this latest explorer has reduced his equipment to the simplest possible form. He does not encumber himself, either with a large and elaborately equipped vessel, or with a numerous personnel. He leaves these precautions to the explorers of the old school. His plan is very daring, but that is no reason why it should not succeed. We must remember that in 1905, Captain Amundsen, with a little coasting schooner of 70 tons and a crew of seven men, succeeded in traversing the Northwest passage, an exploit in which so many illustrious predecessors, provided with the most elaborate equipment, had failed. Lieutenant Shirape is a bold explorer, who has already made a reputation by his work in the Kurile Sea.

The Smithsonian Institution has recently published an interesting paper entitled "Upper Yukon Native Customs and Folk-Lore," by Ferdinand Schmitter, who holds the rank of captain in the Medical Corps of the United States army. Dr. Schmitter describes at some length his experience with the natives while stationed at Fort Egbert in Alaska. His first inquiry on reaching this locality in 1906 was for a medicine-man, but it was not until he had been there two years, and had won the confidence of the people by treating their sick and showing a sincere interest in their customs and mythology, that he was able to meet one, from whom later he was successful in obtaining the series of folk-lore stories which form an interesting portion of the paper. Dr. Schmitter describes the huts, the dress, the food, and many of the customs of the natives. He finds their hygienic conditions unfavorable, and in the summary that brings his paper to a close, he expresses the belief that the influences of civilization would be more valuable if a government official should be appointed or detailed to teach the natives agriculture, to act as a health officer, and to compel them to live in a sanitary manner, to supervise the care of the sick, to establish a commissary where they may buy at moderate prices, to act as police, and to make further recommendations for their benefit.

AERONAUTIC NOTES.

Brookins's high flight at Atlantic City on July 9th lasted one hour and two minutes. He ascended steadily for nearly an hour and was only ten minutes descending. His greatest height as measured from the ground was 6,175 feet, but the Richard recording barometer he carried registered 6,200. The former figure was given as official. It surpasses by 1,635 feet Latham's record made shortly before at Rheims and by 1,236 feet Brookins's former record made at Indianapolis. This daring young aviator thus practically climbed as high as the summit of Mt. Washington, while he demonstrated his skill in gliding by descending nearly the entire distance with his motor stopped. This is the first time that, starting from sea level, an aeroplane has ascended to a height of a mile.

The death of England's most noted aviator, Charles Stuart Rolls, the second day of the Bournemouth (Eng.) aviation meeting, owing to the breaking of the horizontal rudder or the tail of his Wright biplane as he attempted a sudden and sharp descent, cast a pall over England's first great 1910 meet. Nevertheless this accident did not deter other wealthy young aviators from taking chances and making new English records. Mr. Armstrong Drexel, in two successful attempts at bettering the height record with his Blériot, reached 1,950 and 2,490 feet, respectively. In the first descent he is said to have glided from an elevation of 1,000 feet. After flying 90½ miles across country from London to Bournemouth in 2 hours and 35 minutes, Graham White made a high flight of 1,660 feet and afterwards covered 55 miles 1,200 yards in an hour and 55 seconds. Christiansens covered 83 miles 1,300 yards in 2:20:52½; while Capt. Dickson made a spectacular flight over Bournemouth at a height of 1,200 feet. Many other noteworthy flights were also accomplished.

During the last two days of the second annual aviation meet at Rheims, France, many more record-breaking flights were accomplished, especially by the monoplanes. Leon Morane, on a Blériot monoplane, covered 5 kilometers (3.1 miles) in 2 minutes 48 seconds, or at the rate of 66.53 miles an hour. He flew 20 kilometers (12.4 miles) in 12¾ minutes (58.44 miles per hour.) After Labouchère had flown 340 kilometers (211.26 miles) in 4 hours, 37¾ minutes (45.69 miles per hour) the seventh day of the meet, Olieslaigers increased this new Antoinette record with a Blériot machine on the last day to 393 kilometers (244.20 miles) in 5:03:05 (48.34 miles per hour). In other words he flew farther than from New York to Boston in an air line without a stop and at the speed of the fastest express. Leblanc won the 22-kilometer (13.66-mile) cross-country flight prize with his Blériot.

The official records made at the Indianapolis aviation meet put at variance some of the figures published in the SCIENTIFIC AMERICAN of June 25th. To begin with Walter Brookins made but one short turn in 6 2-5 seconds, thereby reducing by 4 seconds the record made a short time before by Orville Wright. Brookins's height record as determined by a double triangulation calculation made by the city engineers was 4,939 feet instead of 4,384½. This record was badly beaten, however, by the same aviator on July 9th at Atlantic City, when he reached a height of 6,175 feet. The speed record of 53½ miles per hour, which Brookins was reported to have made—four laps of the 1½ mile course in 6¾ minutes—is questioned by a correspondent who says that Brookins cut the corners and did not cover over 4 miles. Furthermore our correspondent asserts that the Wrights have not yet produced a biplane capable of traveling over 43 miles per hour in calm air with their regular 30 horse-power motor. This, however, is a higher speed than other aviators have attained with equal power and thus the new racer which they are reported to be building should be very fast.

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